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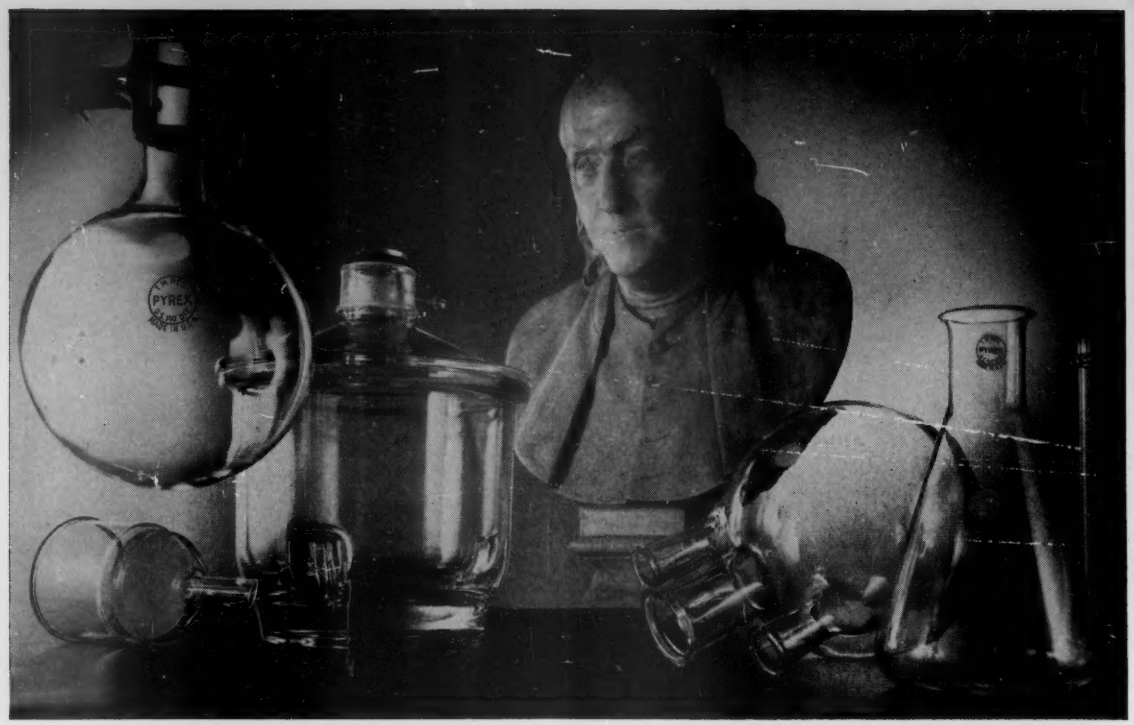

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Scotching a Damaging Rumor

In Europe during recent months we heard from several sources of an apparently widely circulating rumor that scientists who accepted invitations to scientific meetings in Russia or its satellites jeopardized their chances of being admitted to the United States to attend scientific meetings here. One, for example, said: "I should like to attend the sessions in Moscow next month, but I'm afraid to because I want to go to the congress on . . . in the United States in 1957."

The Department of State had not announced any such stupid policy. Yet the rumors persisted, and the only document with which they could be countered was a letter from the Department of State saying that athletes who accepted invitations to compete in eastern European countries did not thereby endanger their opportunities to compete in the United States.

Fortunately, the situation has now been clarified. Thomas J. Killian, deputy chief and chief scientist of the Office of Naval Research, wrote to the State Department for clarification. He received this reply:

"Dear Dr. Killian:

"I am sorry that many scientists, both in this country and abroad, believe that their chances of obtaining visas might be compromised if they visited or even applied for permission to visit eastern European countries, as you indicate in your letter of November 19, 1956.

"The Department's policy in this respect has been consistent and of long standing. With regard to visas, an alien must be found eligible in all respects to receive a visa under our immigration laws. Until such time as an alien actually makes application for such a visa, no assurance can be given that a visa will be issued to him.

"A visit to a country in Soviet-dominated territory in itself is no ground for the refusal of a visa or a delay in its issuance unless such a visit is attended by activities which suggest affiliations with, or advocacy of, the Communist program. Repeated visits to such country, however, may raise a question as to the visa applicant's political affiliations.

"With regard to passports for American scientists, to which I presume you refer in your inclusion of scientists 'in this country,' the Department's policy again has been consistent and of long standing. Passport applications from scientists are processed in accordance with the same laws and regulations which apply to all citizens. It is true that passports are not validated for travel to some countries during periods of tension when the ability of this Government to protect its citizens overseas is in doubt.

"The Department does not have a policy against publication of such a letter as this, and you may feel free to publish or otherwise give wide distribution to it, if you so desire. I further suggest that any instances of scientists being informed by State Department officials that their visits to eastern European countries would compromise their visa or passport privileges be reported promptly to this office in order that investigation may be made at once.

Sincerely yours,
Walter M. Rudolph
Assistant to the Science Adviser"

The reply seems to state about as clearly as can be stated the defensible policy that each application for a passport or visa must be examined on its merits and that attending a scientific meeting in eastern Europe neither disqualifies nor endangers a later application to the United States Department of State.—D. W.

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Uniqueness of Man

G. W. Beadle

Although man's widening horizons of understanding have made it increasingly clear that his own importance as measured in terms of cosmic space and time is vanishingly small, it is still true that on the planet earth his attainments and influence have been matched by no other species. Among the many other respects in which he is unique, he alone is able to investigate his evolutionary past and to speculate intelligently about those aspects of it that he cannot directly explore.

The quest for his own origins has led man to the concept of organic evolution, a concept that is surely one of his greatest intellectual achievements. It is a concept that challenges him to push further and further backward, in his search for understanding, to the very beginning of life on earth—and beyond that to the prelife evolution that must have been before. Short of the origin of the universe, there is no point in the process beyond which his urge to explore no longer extends.

There is as yet no general agreement among cosmologists on how, exactly, the universe is built, or how it began. Some would believe that it began some 5000 to 7000 million years ago as a giant explosion of an enormously dense "primeval nucleus" (*1*). The present expanding universe is then believed to be a continuation of that explosion. Others prefer to believe that matter is being and always has been created continuously and that the universe is in a steady state of expansion, without beginning and without end (*2*).

Observational evidence is being accumulated by astrophysicists that may before long answer such questions. Whatever the answers may prove to be, there is increasing reason to believe that the elements have evolved and are now evolving in orderly ways, beginning with hydrogen. The detailed mechanisms by which they thus arise are becoming more and more clearly understood as nuclear physicists and astrophysicists continue their collaborative investigations (*3*).

Chemical Evolution

At the time the crust of the earth became solid, presumably some 4000 to 5000 million years ago, conditions favored the accumulation of molecules, and these in turn went through an evolutionary sequence as the environment changed. In the early phases of the molecular stage of evolution, only simple molecules were formed. At one period, there were probably present in abundance such gases as hydrogen, ammonia, methane, and water vapor—with perhaps little or no free oxygen (*4*). Later, more complex molecules, such as amino acids and perhaps simple peptides, were formed (*5*).

In the more advanced phases of this period, it is believed that there appeared a molecule with two entirely new properties: the ability systematically to direct the formation of copies of itself from an array of simpler building blocks, and the property of acquiring new chemical configurations without loss of ability to reproduce. These properties, self-duplication and mutation, are characteristic of all living systems and they may therefore be said to provide an objective basis for defining the living state.

Evidence is accumulating that the nucleic acids of present-day organisms possess these two properties (*6*), and it is perhaps no longer useless to speculate that the first "living" molecule might have been a simple nucleic acid, perhaps protected by an associated simple protein. From such a viruslike system it is possible to conceive how present-day organisms might have evolved. Although the details were surely complicated far beyond the ability of man in his present knowledge to comprehend, it is possible that no principles other than those known to modern biology have to be invoked to explain the entire process.

Through mutation and aggregation of these first "living" molecules, which might be called primitive genes, multimolecular forms that depended for reproduction on preformed building blocks would be expected to arise with the ability to catalyze some of the reactions by which their building blocks were derived from simpler molecules. In a stepwise manner, with each step consisting of a mutation conferring a selective advantage, complete autonomy could be achieved (*7*). The single-celled green algae represent such an evolutionary stage, with each cell perhaps containing tens to hundreds of thousands of times as much replicating genetic material as did the original ancestral form. This phase of evolution may have lasted 1000 million years or more.

The evolutionary gap between unicellular forms and the most complex multicellular organisms may have been much more easily and rapidly bridged than was that between the unimolecular and unicellular systems. Presumably the early stages in the origin of multicellular plants and animals consisted of simple colonies of like cells. Division of labor among such cells—cellular differentiation, biologists call it—was a logical next step.

In the animal line of descent, differentiation of cells and subsequent evolution of tissue and organ systems made possible the nervous system. It is the extraordinary development of this system in man that sets him apart by such a wide

Dr. Beadle, retiring president of the AAAS, is chairman of the Division of Biology at California Institute of Technology, Pasadena. This article is based on his AAAS presidential address, which was given 27 Dec. 1956 during the New York meeting.

gap from all his contemporary species. It underlies the remarkable development of his intellect, his ability to carry through complex reasoning processes and his highly developed systems of communication.

Cultural Inheritance

The ability to acquire and communicate knowledge has enabled man to supplement biological inheritance with cultural inheritance. No other species has ever developed this type of inheritance to any appreciable extent. The reactions of individuals and groups of the human species to various environmental situations are obviously a result of complex interactions of the two types of inheritance (*8*).

Although cultural inheritance may have had its first beginnings a half-million years or more ago, it has expressed itself most spectacularly in the last half-dozen millenia. Ancient and modern civilizations with their technologies, arts, music, literatures, sciences, and religions are its products.

Modern technology and science have evolved within a period of a few thousand years. They in turn have made possible the industrialization that has in the past few centuries developed to such a high degree in a few nations of the world.

The recent evolution of cultures, especially in technologic and industrial directions, has created for man an entirely new set of opportunities together with a closely interrelated group of problems. As agriculture provided more food, populations grew. Further technology was catalyzed. Tools evolved, first of stone and wood, then of bronze and copper, and finally of iron and steel. Manpower was supplemented by domestic animals and by machines driven with the energy of burning wood, coal and oil. At the same time, the art and science of medicine was responsible for spectacular increases in life-expectancies. This helped populations to grow still more rapidly.

All this is an old and well-known story. It is also well known that with urbanization, industrialization, and improved health practices, birth rates tend to fall off, but only after a lag of several generations. This lag is especially marked in those cultures in which for one reason or another education and accompanying industrialization develop very slowly. This is because in general it is easier to introduce drugs and physicians to such cultures than it is to raise markedly their levels of education and technology. Thus, as the demographic transition is made in one culture after another, populations tend to increase sharply and then become stable.

War

For a world with half its nations industrialized and half not, and with its natural resources very unequally distributed, the present population of more than 2500 million is far too large. More than half the people of the world are underfed, are poorly housed, receive little modern medical care, and are inadequately educated. It is small wonder that populations who see so little hope in other directions can be so easily stirred to rebellion and led to war by power-hungry demagogs, charlatans, and other persuasive men of little wisdom.

Overcrowding of hungry people who see little hope for a brighter future is by no means the only cause of war, but it is surely an important one. And without the slightest doubt, war is the most serious of civilization's immediate problems.

Human warfare is as old as man himself. As a part of man's culture, it has evolved from primitive forms of man-to-man combat through the many intermediate stages to its present highly perfected state. During this course, wars have become progressively larger and more devastating.

With the development of nuclear weapons, we see a significant discontinuity in this evolutionary sequence. Up to this point wars were largely self-regulating in one way or another, usually through the achievement of victory, hollow though it might have been, by one party. With wars of nuclear weapons, it is entirely conceivable that there will no longer be victors. Participants and onlookers, too, may perish from blast, radiation, and starvation.

This is why a war of nuclear weapons is said to be unthinkable—why there is now "no alternative to peace." Logically it is so. But war never has been logical. In the present state of armament, there can be no guarantee that an illogical lunatic or madman in a position of power will not pull the trigger that will set one off.

Aside from the fact that the present maintenance of peace through mutual threat of annihilation is intolerably dangerous, the pyramiding cost of supporting superior military strength and defenses against potential enemies seriously competes with alternative activities that would decrease the probability of war. It is no new thought that if the intelligence, imagination, creativity, and drive that now go to maintain military might, not to mention the raw materials and energy devoted to the same purpose, were wisely used for peacetime purposes, the incentives to wage war could be largely abolished.

In spite of the fact that there is wide agreement with the thesis that war is more nearly than ever synonymous with madness and that decreasing its likelihood is the greatest need of our time, progress is made with discouraging slowness. The obvious solution through mutual disarmament fails because there is no mutual trust among nations.

Food and Population

Although the task of preventing a major war in the immediate future is assigned to the statesmen of the world, with special responsibility in the hands of those of the more powerful nations, there are many ways in which science can and must contribute toward basic and long-term solutions.

It is difficult for men with empty stomachs to know right from wrong. If the presently available scientific knowledge of agriculture were applied on a world-wide basis, hunger could become unnecessary. But the economic, political, and social problems inherent in doing so are made enormously more difficult by the fact that they must be solved in terms of a world divided into many nations. Solutions are possible, and every possible effort should be devoted to attempts now being made to arrive at them.

In the time required to increase food production sufficiently to feed more than 2500 million people adequately, there will, unfortunately, be many more than that to feed. With the present excess of births over deaths, the world's population is annually increasing by 30 to 40 million. Food production must therefore more than catch up with present needs. This will require that efforts be stepped up by even larger factors. More land must be brought under cultivation, and yields must be increased. This means more fertilizer, more water for irrigation —perhaps through recovery from sea water—and more plant and animal breeding. The food of the oceans will have to be harvested in increasing amounts, and the practicability of entirely new methods of agriculture, such as those of algal farms, will have to be explored.

All this will require more technology and a great extension and evolution of industry. Consumption of raw materials and energy will rise markedly. The general level of education will have to be raised on a world-wide basis. Better use of manpower resources, especially at the intellectual level, will be increasingly necessary.

If the peoples of the world can somehow be induced to work together, there is no apparent reason why all of this cannot be done (*9*). While it is being done, what will be the trend of popula-

tion growth? With the spread of technology and education, will birth rates in fact fall off until populations reach approximate equilibrium in size? It is a widespread belief that they will. The decreased birth rates that accompany education are attributed to an increased desire to limit family size plus greater knowledge of birth control techniques. If so, education and the discovery and development of improved methods of birth control may in time largely solve the quantitative problem of population growth.

However, the hope that prosperity and education will continue automatically to lead to population stabilization through voluntary birth control has been considerably dimmed by the marked postwar increases in birth rates in the United States and other industrialized nations. Indeed this phenomenon raises the question of whether Malthus was not fundamentally right (*10–12*), in spite of his many detractors of recent times.

Whether or not the present high birth rates in industrialized nations are temporary and will in the long run be smoothed out at a lower level, the whole question of the adequacy of voluntary family limitation in regulating the growth of populations will have to be faced sooner or later. This is because the problem of control may not be a wholly quantitative one. Because it will inevitably be uneven in its application, voluntary and individual family control is bound to lead to changes in population composition. Differences in net reproductive rates may depend on such factors as genetic background, cultural history, and economic status. Whatever their cause, they may well produce population changes of the greatest significance to man's future. For example, it has many times been pointed out that under a system of voluntary birth control the less fit intellectually may be lacking in social responsibility and might therefore have a higher than average net reproductive rate. If differences in intelligence of this kind have an important genetic component, there is a theoretical possibility that progressive intellectual disintegration could become an important factor in shaping the nature of future populations.

Alternatives to population control through voluntary decisions on the part of individuals—society-imposed family quota schemes, to mention one conceivable possibility—raise religious, moral, and ethical questions of such magnitude that no responsible society has ever given them serious consideration except under the most unusual and special circumstances. It could well be that societies may eventually be forced to face this unpleasant problem more realistically than they so far have (*11, 12*).

At the same time that solutions are being sought to problems of population growth, food production, raw material supplies, energy resources, and the training of manpower, effective ways must be found to abolish the threat of war that has so long and so constantly plagued man. All responsible statesmen know this, and they have pointed out repeatedly that the one formula most likely to succeed is the development of a union of nations in which authority and power are commensurate with responsibility (*13*). There appears to be no other way to protect individual nations against those unwise and irresponsible acts of other nations that are the precursors of violence. It is, of course, now a common hope of many nations and many individuals that the United Nations will evolve into just such a union. If it is to do so, the hope must spread widely and grow to the intensity of a demand.

There is no reason why individual nations under such a union cannot continue to approach their internal problems in a variety of ways and with the hope that ultimately the wide gaps that now exist among nations of differing political, social, and economic ideologies will be closed through convergent social evolution.

Cultural and Biological Self-Direction

Man's evolutionary future, biologically and culturally, is unlimited. But far more important, it lies within his own power to determine its direction. This is a challenge and an opportunity never before presented to any species on earth.

It has been clear for a long time that man is potentially capable of cultural self-direction—that he could, to a much greater extent than he now does, consciously select his cultural objectives. What is not so obvious is that it has now become possible to exercise a comparable degree of control over his purely biological evolution.

Through the understanding of heredity that man has gained within the past half-century, he has acquired the power to direct the evolutionary futures of the animals he domesticates and the plants he cultivates. At the same time and in the same way, he has won the knowledge that makes it possible deliberately to determine the course of his own biological evolution. He is in a position to transcend the limitations of the natural selection that have for so long set his course (*8*).

But knowledge alone is not sufficient. To carry the human species on to a future of biological and cultural freedom, knowledge must be accompanied by collective wisdom and courage of an order not yet demonstrated by any society of men. And beyond knowledge, wisdom, and courage, faith, too, will be essential. Man must have faith in himself. He must have faith in the rightness and goodness of his goals. And many would add that he must continue to have spiritual faith.

Faith, belief, and the urge to go on and on have themselves come out of man's past as a part of the evolutionary pattern that has fashioned him into the unique being he is. In his uniqueness, he is capable of attaining heights far greater than his most magnificent cultural achievements of the past.

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Mechanism of Carbohydrase Action

M. A. Jermyn

The nature of the intermediate complex that is formed between enzyme and substrate during the action of hydrolytic enzymes is one of the oldest problems in biochemistry and one that is still far from being solved. Koshland (*1*) has pointed out the probability that there is more than one type of reaction mechanism and intermediate complex involved and has reviewed the criteria for distinguishing various types of interaction.

Although Koshland and other reviewers have drawn many of their examples from the carbohydrases, it can nevertheless be said that there is less agreement on the reaction mechanisms involved in the action of these enzymes than there is on the reaction mechanisms for esterases, phosphatases, and proteases. This is possibly because the immense variety of readily accessible carbohydrases has precluded the intensive study of more than a handful—those that are most interesting biochemically. It is the purpose of this article (*2*) to correlate some observations (*3*, *4*) on the β-glucoside-splitting enzymes of the mold *Stachybotrys atra* with current theories of enzyme action and to show that these observations can be fitted into a conceptual scheme that will cover most of our present knowledge of the carbohydrases.

It is usual to account for the observed facts (*1*) (competing hydrolase and transferase actions, retention of configuration, rupture of the glycosyl-O bond rather than the O-aglycone bond) about the simpler carbohydrases by some such two-stage reaction scheme (*5*, *6*) as

$$E\text{O-H} + R\text{O-glycosyl} \rightarrow E\text{O-glycosyl} + R\text{O-H} \quad (1)$$

$$E\text{O-glycosyl} + R'\text{O-H} \rightarrow E\text{O-H} + R'\text{O-glycosyl} \quad (2)$$

where E represents the enzyme molecule and R represents the aglycone, and where the enzyme is acting as a hydrolase when $R' = \text{H}$, otherwise as a transferase.

Morton (*7*), in discussing a similar scheme for phosphatases, has pointed out that the binding of R'O-H at the second —"water"—site is probably quite as specific as the binding of the substrate at the site involved in the first stage of the reaction, and he has postulated that the enzymic reaction may be blocked by the binding of substances at the water site which are unable to act as acceptors. This type of inhibition—anticompetitive inhibition, where the inhibitor prevents the dissociation of the enzyme-substrate complex—has recently been discussed with examples by Dodgson, Spencer, and Williams (*8*) and may well be more common than they believe. Anticompetitive inhibition will give straight lines in a Lineweaver-Burk plot (reciprocal of velocity plotted against reciprocal of substrate concentration) which are parallel for the inhibited and uninhibited reactions (*9*). Although, as Ogston has pointed out (*10*), it is impossible to argue unequivocally from enzyme kinetics to any single type of enzyme mechanism—for example, the parallel lines in the Lineweaver-Burk plot do not necessarily imply anticompetitive inhibition—nonetheless, the probability of such a mechanism may be used along with other lines of evidence to frame a working hypothesis.

Beta-glucosidase of Stachybotrys atra

A study of the breakdown of *p*-nitrophenyl-β-glucoside by the β-glucosidase of *Stachybotrys atra,* in which the kinetics were followed by measuring the liberated *p*-nitrophenol, showed that polyhydroxylic organic molecules inhibiting or activating the enzymic reaction could be divided into three classes: (i) typical competitive inhibitors; (ii) substances for which the Lineweaver-Burk plot of the inhibited (or activated) reaction gave a straight line parallel to that for the control reaction and above (or below) it, and (iii) substances showing a behavior intermediate between the behavior of classes i and ii.

When degree of inhibition was plotted against the concentration of inhibitor for inhibitors of the second type, a sigmoid curve was obtained identical in type with the typical dissociation curve that relates reaction velocity and substrate concentration.

The interpretation of these results which is adopted in this article (an enlargement of the point of view presented in an earlier paper, *3*) is that inhibitors of the second type are bound reversibly at the acceptor center without being able to act as acceptors. Furthermore, since the reaction actually observed to be activated or partially inhibited is the liberation of *p*-nitrophenol, it follows that reaction 1 cannot proceed unless a suitable acceptor to complete reaction 2 is also bound to the enzyme.

The simplest way of explaining this observation is to invoke the "double displacement" mechanism of Koshland (*1*), which supposes that substrate, active center, and acceptor are bound into a single complex that does not break up until group transfer from substrate to enzyme to acceptor is complete. To establish this firmly, it will be necessary to check that the β-glucosidase of *Stachybotrys atra* ruptures the bond between the glucosyl carbon and the bridge oxygen with final retention of configuration in the way that has already been demonstrated for another β-glucosidase (*11*).

Activators of the second type may be interpreted as being bound with high affinity at the acceptor site and as acting as more efficient acceptors than water. This has now been checked (*12*) by observing the molar ratio of the reducing sugar and the *p*-nitrophenol liberated during hydrolysis of *p*-nitrophenyl-β-glucoside by the β-glucosidase of *Stachybotrys atra.* In control experiments, this ratio is unity, and it has been shown (*3*) that the affinity of the acceptor center for free glucose must be very low; this contrasts with the behavior of the β-glucosidase of *Aspergillus oryzae,* where the ratio of reducing sugar to *p*-nitrophenol is 0.7 to 0.8 at 50 percent hydrolysis, and where oligosaccharides are formed during the hydrolysis (*13*). With the *Stachybotrys atra* enzyme in the presence of 0.1*M* glycerol (type ii activator) the ratio is reduced to 0.5, but in the presence of 0.01*M* phenyl-α-cellobioside (type ii inhibitor) it remains at unity. Thus there is transfer to an activator bound at the acceptor center, but not to an inhibitor. In fact, 1-glyceryl-β-D-glucoside is readily isolated from enzymic digests in which the nitrophenyl glucoside has been hydrolyzed in the presence of glycerol.

Both active centers appear to have some binding power for almost all polyhydroxylic compounds, and the combination of type ii activation and competitive inhibition gives a system in which,

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for a given combination of enzyme and active agent, there is activation at high concentrations of substrate and inhibition at low concentrations of substrate. Similarly, very few weak inhibitors behave as purely competitive inhibitors, and β-glucosides of low affinity for the substrate center show considerable type ii inhibition of *p*-nitrophenyl-β-glucoside breakdown: as might therefore be expected, there is inhibition by excess substrate in the breakdown of all aryl β-glucosides. The elements of specificity at both centers have been worked out, especially at the substrate center where both a structure resembling that of the D-glucose molecule and the possession of an aryl-β-glucoside linkage appear to confer an affinity for the center on the "substrate" molecule that decreases, the further its structure departs from one or both of these feaures. Both must be present before the molecule becomes a true substrate for the enzyme.

These observations are in qualitative agreement with the conclusions of Morita about the normal limit of specificity of a wide variety of glucosidases as he has recently summarized them (*14*). At the acceptor center it seems that both an α-glycosidic linkage and portions of the glucose molecule confer specificity. There is sketchy evidence that specificity at the acceptor center may be directed toward the configuration about carbon atom No. 2 (C-2) of D-glucopyranose in the same way that the specificity at the substrate center is known to be directed to the configuration about C-3 (*3, 15*). L-Arabinose is a fairly good type ii inhibitor and agrees with glucose in the configuration about C-2 (D-arabinose is a weak competitive inhibitor); 2-deoxyglucose (a competitive inhibitor) with no hydroxyl group at C-2 shows no affinity for the acceptor center, nor do other monoses with a reversed configuration. On the other hand, D-glucose itself shows little affinity.

Other Enzymes of Stachybotrys atra

Stachybotrys atra produces at least two other enzymes capable of hydrolyzing the β-glucosidic linkage, both of which seem to be produced adaptively by the mold as a response to growth on cellulose under different circumstances. One, the "cellulase" of Thomas (*4*), splits poly-β-glucose chains at random, reducing cellulose to a mixture of glucose and cellobiose. It does not attack cellobiose even though cellotriose is a substrate, nor does it attack *p*-nitrophenyl-β-cellobioside as the *Irpex* cellulase of Nisizawa (*16*) does. A second, the "cellobiase" of Youatt (*17*), attacks cellobiose and poly-β-glucose chains by removing the terminal nonreducing glucose residues. It is a β-glucosidase but not a β-cellobiosidase, and it will split phenyl-α-cellobioside to glucose and phenyl-α-glucoside. The basic elements of the specificity of the three β-glucosidases of *Stachybotrys atra* at the substrate center for effective enzymic action are fairly clear.

Table 1. Specificity requirements around the β-glucosidic linkage for β-glucosidase, cellobiase, and cellulase.

Enzyme	Specificity requirements around the β-glucosidic linkage	
	Glucosyl moiety	Aglycone moiety
β-Glucosidase	One glucose residue	Aryl group
Cellobiase	One glucose residue	Aryl group, alkyl group, one or more glucose residues
Cellulase	At least one glucose residue	At least one glucose residue

In Table 1 it is clear that, for cellulase, either the specificity of one moiety of the molecule will eventually have to be amended to "at least *two* β-linked glucose residues" or else there is an overriding requirement that the sum of the two moieties shall be at least three glucose residues. It is here proposed to classify enzymes of the type of the β-glucosidase and the cellobiase with a requirement for a specific number of monose residues in the glycosyl moiety as "exoglycosidases." Enzymes that can hydrolyze nonterminal glycosidic linkages—that is, enzymes for which the number of monose residues in the glycosyl moiety is restricted to a minimum only—are classified as "endoglycosidases."

Other pairs of polysaccharidases similar to the cellulase pair from *Stachybotrys atra* are known—for example, α-amylase and "gluc-amylase" (*18*) and the polygalacturonases I and II of Ozawa and Okamoto (*19*). There is at present no knowledge about the specificity involved in binding at the substrate center of the cellulase and cellobiase without effective enzyme action; for exoglycosidases, at least, it is obvious that the labor involved in synthesizing the compounds needed to test even the simplest hypothesis will preclude a ready answer to such questions.

There is some preliminary evidence that the cellobiase of *Stachybotrys atra* is a transferase, but no knowledge for either cellobiase or cellulase of the specificities involved in binding at the acceptor center.

Hypothesis about Carbohydrases

The hypothesis about carbohydrases which is proposed may be briefly stated as follows. The activity of all carbohydrases that act as transferases with retention of configuration (β-amylase is the only well-studied exception to this type) depends on the simultaneous binding at contiguous active sites of two suitable substrate molecules. In principle, the over-all reaction

$$\text{Gly-O}R + POQ \rightleftharpoons \text{Gly-O}P + Q^{+} + RO^{-}$$

where Gly represents a glycosyl radical and *P*, *Q*, and *R* represent hydrogen atoms or suitable organic radicals, is reversible, but in practice the free energy change of the reaction drives the reaction sufficiently far to the right in most cases for Gly-O*R* to be labeled "substrate" and *POQ* "acceptor." The blocking of one or both active centers will inhibit the enzyme; the substrate centers are occupied by competitive inhibitors, and the acceptor centers by anticompetitive inhibitors.

Both active centers have specificity directed toward the nature and configuration of the groups about the susceptible bonds, but this is not absolute, and a wide variety of compounds can generally be bound to some degree. As the number of kinds of molecule that can be accommodated to these specificities diminishes, there is a change of enzyme type from rather general hydrolases with some transferase activity to narrowly specific transferases.

The work of Whitaker (*20*) with the cellulase of *Myrothecium verrucaria* suggests that, when these specificities are directed toward sufficiently large molecules, they may not be absolutely constant. Brief exposure of the enzyme protein to denaturing conditions changes the activities toward different substrates to different degrees, and Whitaker believes that this is because the slightly altered shape of the enzyme surface—the "lock"—may allow various substrate molecule "keys" to fit into it better or worse than before.

In any case, as the complex net of forces involved is directed toward larger molecules, it must become increasingly liable to disturbance, and the difference between enzymes of apparently widely different specificities may amount to very little in terms of the configuration of the enzyme surface. The way in which many fungi can produce a number of enzymes of very similar specificity, or can be switched from producing one enzyme to producing another related one by small changes in the environment, suggests

that these enzymes are variants of a few basic patterns.

We may (with some reservations) draw the postulated reaction scheme diagrammatically as shown in Fig. 1. The nature of the active center *E* which catalyzes the nucleophilic attack on the bonds cannot as yet be specified. The important question left undecided is whether the reaction is one of metathesis or not—that is, is *ROQ* a product of the reaction, or are the final products of the reaction besides Gly-O*P* due to the solvolysis of Q^+ and RO^-.

So far as I am aware, direct metathesis of the type

$$\text{Gly}_1\text{-O-aglycone}_1 + \text{gly}_2\text{-O-aglycone}_2 \rightleftharpoons \text{gly}_1\text{-O-aglycone}_2 + \text{gly}_2\text{-O-aglycone}_1$$

has never been observed, and isotope experiments have been done under conditions where *POQ* = HOH (or *P*OH in equilibrium with water), although it is obviously possible to devise critical experiments if the necessary labeled substrates can be synthesized. Although direct metathesis may be stereochemically and thermodynamically unlikely, it is possible to imagine arrangements of *E* such that the required electronic mechanism is too bizarre. It is suggested that a watch should be kept for this type of mechanism in suitable cases such as the branching enzymes.

The apparent reversal of the reaction of some carbohydrases—for example, the formation of alkylglucosides by almond emulsin in the presence of high concentrations of alcohols and glucose (*21*)

$$\text{Glu-O}R + \text{H-OH} \rightleftharpoons \text{Glu-OH} + R\text{-OH}$$

would be most readily explained by metathesis if the double-displacement reaction mechanism is accepted—that is, if Glu-O*R* + H-OH and Glu-OH + *R*-OH give the same intermediate state.

The primary attachment of the substrate molecule to the enzyme appears to be through the oxygen of the glycosidic linkage; by analogy, a similar attachment of the acceptor groups appears likely. For the β-glucosidase of *Stachybotrys atra*, attachment through S and NH groups also occurs (*2*), and some enzymic activity against S-glucosides can be demonstrated. Since affinities of O-, N-, and S-glucosides are of the same order of magnitude, it does not appear that direct coordination to a metal is involved; indeed, no carbohydrase is known to be a heavy-metal enzyme.

Furthermore, the more easily electrons can be withdrawn from the bond between the glucosyl carbon and the bridge atoms, the more readily this bond should be split by nucleophilic agents; in fact, the expected order of ease of withdrawal of electrons from this bond with variations in the bridge atom (NH > S > O) is found to be the same as the order of ease of alkaline hydrolysis. Yet it is the opposite of the order of ease of enzymic hydrolysis. It must therefore be supposed that there is some other property of a bridging oxygen atom that allows it to take part in the formation of an intermediate complex with at least four groups bound to the active center and that is crucial for enzymic action.

This interpretation of the matter is supported by the observation that aryl glycosides are more readily hydrolyzed than alkyl glycosides by both simple glycosidases and alkalis. The electron-attracting properties of the aromatic ring provide a simple explanation for both cases. Since the observed effects are here in the direction predicted by the ordinary electronic theory of reaction mechanisms, the effects of replacing O by NH and S cannot be the result of electronic effects on the labile bond.

It has recently been recognized (*22*) that at least one "carbohydrase" (bacterial hyaluronidase) can act by an unsaturating rather than by a replacement mechanism. Such a mechanism demands an enzyme that can form an activated complex without involving an acceptor molecule, the complex then decomposing to unsaturated products by well-known electronic rearrangements.

The Nature of Specificity

It has come to be realized that many observations on the relative lability of the glycosidic linkage in different classes of compounds cannot be explained if the glycopyranose ring is visualized in the form of the flat ring by which it is conventionally represented. The ring in fact shares with the cyclohexane ring the property of potentially existing in "boat" and "chair" configurations, with one chair form being preferred both in the solid state and in solution (*23*). By considering the distribution of axial and equatorial bonds in glycosides of various types, it can be shown (*24, 25*) that the glycosidic oxygen is sometimes readily accessible for attack by the proton during acid hydrolysis and that it is sometimes heavily masked by screening groups.

Similar considerations apply to enzymic hydrolysis, and Gottschalk (*15*) predicted the critical importance of the hydroxyl group on C-3 of the glucopyranose ring for attachment at the substrate center of β-glucosidases, by considering the distribution of groups in the chair form of β-glucopyranose. Even when the glycose ring is attached to the enzyme surface, it is apparent that free movement of the aglycone portion of the molecule allows an infinite number of configurations of the glycosidic linkage;

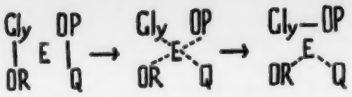

Fig. 1. Postulated reaction scheme.

it is here suggested that in endoglycosidases the active center and the susceptible bond can be in only one of their possible relative orientations if the active complex is to be formed, and that this is achieved by a highly specific binding of both aglycone and glycose. In simple glycosidases, there is considerable latitude in orientation about the preferred configuration and no need for a specific binding of aglycone.

For the enzymic hydrolysis of aryl glycosides, it is known that ortho-substitution is often inhibitory, even though acid hydrolysis is speeded up by the same substitution (*26*). It appears that this effect is due to hindered rotation about the glycosidic linkage. The β-glucosidase of *Stachybotrys atra* is almost completely inactive against derivatives of phenyl-β-glucoside with one or two ortho positions substituted by heavy groups, and examination of molecular models of such a substrate as 2,6-diiodo-4-methyl-phenyl-β-glucoside shows that it is impossible to rotate the glucosyl and aglucone portions of the molecule past each other. It is apparent that enzyme action can take place only when the glucosidic linkage can be suitably oriented. There seems to be, however, no valid evidence that there is for any simple glycosidase a specific enzymic affinity toward any particular nonpolar aglycone group such as has been suggested by some authors (*27*).

The Active Center

The picture of carbohydrase action presented here still leaves the nature of the active center unclear. About it lie two molecules held in such orientation that both simultaneously undergo the same attack—electron withdrawal from the glycosidic oxygen and nucleophilic attack on C-1 (or their equivalents for the acceptor molecule). There is very little evidence on the action of group-specific inhibitors on most carbohydrases, which are in general inactivated only under conditions that denature most protein molecules in any case. The only well-studied exception to this statement, β-amylase, is by definition excluded from the type of carbohydrase to which the generalizations of this paper apply.

Myrbäck (*6*) has postulated from the results of inhibition experiments that the functioning of yeast sucrase depends on one or more carboxyl groups on the enzyme molecule being present in an un-

charged, uncomplexed form. As with similar demonstrations for other enzymes, it still remains uncertain what part, if any, the carboxyl groups play in formation of the actual enzyme complex.

It is perhaps significant that many carbohydrases seem to be stabilized or activated by macromolecules of rather unspecific type—for example, *Myrothecium* cellulase is activated by a number of proteins (*28*); yeast sucrase is stabilized by a mannan that seems to be identical with the structural mannan of the yeast cell (*29*) and *Stachybotrys* β-glucosidase (*30*) and cellulase are both stabilized by a complex polysaccharide that seems to be a normal metabolic product of the mold. A large area of enzyme surface must be masked in some way to keep the molecule in the active state. The functioning of the enzyme may involve the configurations of equally large areas of enzyme surface rather than small "active centers" or prosthetic groups.

When even such an enzyme as testicular hyaluronidase—an endoglycosidase restricted to alternate glycosidic linkages along the chain—has been shown (*31*) to be a transferase with apparently much the same specificity at substrate and acceptor centers, it is apparent that the range of facts that can be explained by the hypothesis is very large. Thus, the cyclizing enzymes that produce the Schardinger dextrins are carbohydrases that can bind one end of an amylose chain at an acceptor center and the same chain at a point six or seven glucose residues away at the substrate center. From the results of Morton (*7*), it seems that many sugar phosphatases are indistinguishable in reaction mechanism from the carbohydrases, and indeed there is no difference in principle between the hydrolysis of, say, glucose-1-phosphate and an arylglucoside.

The postulate of a high specificity for the acceptor center, water being a rather inefficient competitor with other potential acceptors, means that the problem of the relatively high efficiency of transferase action as against hydrolase action can be solved without further special hypotheses. Although the acceptor molecules are often transient intermediates of the enzymic hydrolysis, present at very low concentrations at any time, the fact that quite a large portion of the reaction proceeds by transfer in these cases is readily explained by assuming suitable values of the affinity constants. In the event that affinity for a complex molecule as acceptor is high and for water nearly or quite negligible, the enzyme will be a pure transferase, and a "primer" will have to be added to allow its action to begin.

Takano (*32*) has shown that four nominally closely related enzymes (the β-glucosidase and β-galactosidase of apricot and elder) have each perfectly distinct acceptor specificities. The simple method of naming a carbohydrase by adding *-ase* to the name of its "substrate" is seen to be inadequate when the dual specificity is so strongly marked.

Oparin and Bardinskaya (*5*) have protested against the postulation of mechanisms for the transferase action of potential hydrolases that do not involve the intervention of water on the ground that these reactions do not take place in nonaqueous media. Since most active proteins are not in their normal physicochemical state in these media in any case, and since they would not be expected to exhibit their characteristic behavior, the question of whether the presence of water is necessary to activate transferases is an academic one. By suitable definition of the "active complex," its presence can be made essential or irrelevant. Carbohydrases can be activated or stabilized by large excess of light-metal cations in a way strongly reminiscent of the stabilizing effect of macromolecules; like water, they seem to maintain the necessary conditions for enzymic transfer rather than to take part in it, and their inclusion as part of the reaction mechanism is likewise a matter of definition.

Conclusion

The hypothetical structure erected here depends on a single crucial observation, the effect of anticompetitive inhibitors and activators on aglycone liberation by *Stachybotrys atra* β-glucosidase, an enzyme which apparently acts by the "double displacement" mechanism. Such behavior should be readily observed in other related enzymes, if it exists there.

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Suggestions for Contributors to *Science*

To assure publication of papers with a minimum of delay and to provide readers with subject matter of a wide range and general interest, the AAAS editorial board has established the following policies.

Papers submitted by members and nonmembers of the AAAS will receive equal consideration for publication. Material that is not considered suitable for publication by the editorial board will be returned to the author, and it cannot be the subject of continuing correspondence.

Every article, report, book review, or letter is accepted with the understanding that it has not been published or accepted for publication elsewhere. (Occasionally an important article is reprinted from, or simultaneously printed with, another periodical, usually one not readily available to readers of *Science*, but this is always done by special arrangement with the author.)

Every effort will be made to publish papers promptly. This will require the cooperation of authors, who should follow these suggestions: (i) give special attention to concise expressions; (ii) supply clear figures that unquestionably are suitable for reproduction; (iii) see that manuscripts are submitted in the form and style used by *Science*, especially with regard to references, figure legends, table headings, and abbreviations; (iv) on the galley proof, limit alterations to typographic and factual errors; (v) return galley proof promptly.

An article should receive a thorough review before submission, if possible by someone other than the author. If a manuscript for a report is returned to an author for a thorough revision, the revision date will be regarded as the "Received" date for the article.

All manuscripts are to be submitted in duplicate, in order to expedite reviewing by referees and editorial processing. In the event that a paper is returned to an author for revision, one copy will be retained in the editorial office pending final disposition.

Types of Articles

1) *Lead articles.* Lead articles varying in length from about 1000 to 10,000 words are invited for consideration. These may be general articles or reviews of recent advances in some field. Authors should keep in mind the broad audience of *Science* and should employ reasonably nontechnical language that will be intelligible to most readers.

2) *Reports.* All technical papers and comments on them are published in this section titled "Reports." Reports of research should be limited to four double-spaced typewritten pages (about 1200 words). This includes the space occupied by figure or table, references and notes, and the author's name and affiliation. However, statements of conclusions without supporting data will not be accepted. *Such data should be included to the extent necessary.* Illustrative material should be limited to one table *or* one figure.

A fuller account of the kinds of papers suitable for reports will be found in *Science* **124**, 1273 (28 Dec. 1956).

3) *Book Reviews.* In general, unsolicited book reviews are not considered for publication. The editors reserve the right to reject reviews whether solicited or not.

Anyone who undertakes to prepare a book review has accepted certain obligations: to the author, to the publisher, to the editor, to the reputation of the journal, and especially, to the reader.

The reviewer should consider what a reader might like to know about a book. Is it a good book of its kind? In what way is it better or worse than its predecessors? What field does it cover? To what audience is it addressed? If the book is written for a popular audience, the reviewer should judge how successful it is for that audience. Would it be a good book to own? How well does it fulfill the stated aims of the author? If it is not a first edition, how has it been changed, if at all?

The reviewer owes it to the author, who has undoubtedly spent much time and effort on the book, to be fair. He should not magnify minor errors out of proportion to their importance, but he should point out without rancorous or polemical outbursts any weaknesses, important errors, or misconceptions. In short, the reviewer should give an appraisal of the book, not of the author. If it is a generally good book with some faults, or a generally bad book with some good points, this should be made clear to the reader. If the book lies outside the field of the reviewer's competence, which may mean that its title is misleading, he should return it to the editors, or, if someone he knows is competent both in the field of the book and in writing reviews, he should turn the book over to him for review and *notify* the editorial office. If the book does not merit a review, the editorial office should be notified promptly.

Promptness in a book reviewer is an especially desirable virtue. The longer the lapse between publication of a book and its review, the less valuable the review.

Reviews should be no longer than necessary. An optimum length is between 200 and 300 words; an approximate upper limit is 650 words. The length of a review need not be proportional to the merit of a book. In fact, the relation may be one of inverse proportion, for a book with some merit and many defects may require a long review.

The writing should be clear and concise, and the reviewer should remember that he is writing for some nonscientists as well as for specialists in one or another field of science. The reader should be able to tell whether or not the books reviewed in fields other than his own have merit. A librarian, for example, should be able to decide from the review whether or not the book in question should be purchased for library use.

4) *Letters.* The purpose of the "Letters" section is to provide a forum for the expression of comment and opinion. Letters that are highly technical in content or letters that comment on technical articles will be published in "Reports." Letters that comment on something that has appeared in other sections of *Science* and expressions of opinion of interest to the scientific community—including critical opinion—will be published in the "Letters" section.

In general letters will neither be acknowledged nor returned; authors will not receive proof or have an opportunity to order reprints; anonymous letters will be disregarded; letters of 250 words or less will be preferred; the editors reserve the right to make deletions; the editors' decision about whether or not to publish a letter will be final and not subject to continuing correspondence; letters should be typed double-spaced and submitted in duplicate; as is usual in sections of this kind, the editors take no responsibility for the accuracy or soundness of the letters published.

Preparation of Manuscript

For the first copy of the typescript, use a good grade of bond paper, 8.5 by 11

inches. *All copy, including quotations, footnotes, tables, literature references, and legends for figures, should be double-spaced.* Leave margins of at least 1.5 inches at the sides and at the top and bottom. Pages that are heavily corrected should be retyped. Do not insert corrections and additions lengthwise in the margin; the printer works with the typescript mounted in a frame that exposes only a few lines at a time.

Changes in copy and proof. All corrections in manuscript *and* proof should be transmitted to the editorial office in Washington, *not* to the printer.

Illustrations. A brief legend should be provided for each diagram, graph, map, and photograph. It should *not* be incorporated in the figure. All legends are set in type by the printer and, hence, should be typed double-spaced, on a separate sheet of paper.

On the margin or back of each illustration, write in pencil the number of the figure, name of the author, and abbreviated title of the article. All illustrations should be packed carefully with cardboard to avoid damage in mailing. Cracks and marks made by paper clips or pressure of writing ruin photographs for reproduction.

Line drawings should be made with India ink on heavy white drawing paper or blué tracing cloth. Ruled coordinate paper may be used for graphs, provided that it is printed in light blue; the important coordinate lines and scale markers that are intended to appear in the reproduction must be ruled in India ink.

A good size for a drawing is twice that desired for the printed figure, with all lettering and line thicknesses similarly enlarged. One-column-width illustrations are reproduced 2⅛ inches wide; two-column width illustrations, 4-9/16 inches wide; three-column width illustrations 6-15/16 inches wide.

Diagrams containing little detail should be planned so that the printed figure can be made one column wide. For presenting apparatus, a line drawing is usually better than a photograph.

Photographs should have a glossy finish. For satisfactory reproduction, a print must be unblurred and must show sharp contrast between light and dark areas.

When it is desirable to indicate the magnification in photomicrographs, the scale in microns (or other suitable units) should be drawn directly on the print rather than indicated in numerals in the legend. This allows more flexibility in scaling for reduction and, hence, greater accuracy in indicating size of the subject.

Tables. Each table should be typed on a separate sheet and should be provided with a title. Tables should be numbered consecutively with Arabic numerals.

References and notes. The only footnotes are to be those appended to tables and the author's affiliation in lead articles. All other explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively and placed at the end of the article, under the heading "References and Notes."

Preparation of Graphs

These suggestions do not comprise a comprehensive set of suggestions but merely emphasize certain practices that often are disregarded. Most of the recommendations are in accord with those made in American Standards Association publication Z15.3.

Not more than three or four *curves* ordinarily should be shown on the same graph, although more may be included in the case of a family of well-separated curves. Use a solid line for an especially important curve and dashed, dotted, or lighter solid lines for the other curves. No curve or coordinate ruling of the graph should run through any lettering or outlined circles, triangles, and so forth, that are used to indicate plotted points.

Coordinate rulings should be limited in number to those needed to guide the eye in making a reading to the desired degree of approximation. Short scale markers, or "ticks," may be inserted between rulings if this is desirable. The rulings should be light enough not to distract attention from the curves being presented.

Lettering should be placed so as to be easily read from the bottom and from the right-hand side of the graph; that is, the lettering should face either the bottom or the right-hand side of the drawing.

Explanatory comments, supplementary data, or formulas should be placed in the figure legend or in the text. The exception to this rule is the case where there are several curves on the same graph that need separate identification; if practicable, they should be identified by brief labels placed close to the curve (horizontally or along the curve) rather than by single letters or numbers requiring a key.

If it seems necessary to place supplementary information on the drawing proper, the lettering should be kept within the vertical and horizontal limits of the curves or other essential features of the drawing. Otherwise the space occupied by the drawing may be needlessly large, or else the drawing may have to be reduced in reproduction, often to the point where the lettering or other details are illegible.

Scale captions should be placed outside the grid area, usually at the bottom toward the right for the horizontal scale and at the left-hand side toward the top for the vertical scale. The scale caption should consist of (i) the name of the variable plotted, (ii) its symbol, if one is used in the text, and (iii) in parentheses, the abbreviation for the unit of measure; thus, Pressure p (lb/in.^{2}). Avoid using such captions as "Pressure in lb/in.^{2}" and "Pressure in lb per sq. in." The technical terms, symbols, and abbreviations on a drawing should be in accord with those used in the text of the article.

The *horizontal and vertical scales* for a graph should be chosen with care, so as to give a correct impression of the relationship plotted, for the choice of scales has a controlling influence on the apparent rate of change of the dependent variable. Except where a visual comparison of plotted magnitudes is important, the bottom (abscissa) and extreme left-hand (ordinate) coordinate lines do not have to represent the zero values of the variables plotted; this often results in a more effective graph as well as a saving of space.

The numerals representing the scale values should be placed outside the grid area. If the scale values are smaller than unity and are expressed in decimal form, a cipher should always precede the decimal point; thus, 0.20, not .20.

The use of many ciphers in scale numbers should be avoided, and the best way to do this is to reexpress the quantity plotted in terms of a larger unit of measurement. For example, suppose that originally the scale numbers are 15 000, 20 000, 25 000 . . . and that the scale caption is "Pressure (lb/in.^{2})"; these scale numbers can be changed to 15, 20, 25 . . . , provided that the unit is changed to 10^3 lb/in.^{2} If, in this example, the data are correct to three significant figures and it is desirable to indicate this fact, then the scale figures should be 1.50, 2.00, 2.50 . . . , and the unit, 10^4 lb/in.^{2} *Never* use captions of the types: "Velocity $\times 10^3$ in ft/sec" and "Velocity (ft/sec $\times 10^3$)." They are ambiguous, since they do not indicate clearly whether the scale numbers *have been* or *are to be* multiplied by 10^3.

Date of Publication

Although an author will not be notified of the particular issue in which his paper will appear, receipt of galley proof is a fair indication that publication is imminent—usually within 4 weeks. If such a schedule is to be maintained, it is essential that the author mail his corrected galley proof to the editorial office (1515 Massachusetts Ave., NW, Washington 5, D.C.) within 24 hours after receiving it, and that he refrain from making extensive alterations.

Reprints

Reprint orders are handled by the printer, Business Press, Inc., Lancaster, Pennsylvania. An order form will be sent to the author along with the galley proof. If reprints are desired, this form should be filled out and promptly returned to Business Press. Any subsequent correspondence *concerning reprints* should also be addressed directly to Business Press. In the case of authors living outside the U.S.A., the Business Press requires payment in advance for reprints and postage.

News of Science

Asian Nuclear Center

The United States Government has announced that it will provide about $20 million to help establish the proposed Asian nuclear center that is to be located in Manila. The money will be used for capital expenditures and initial operating costs.

A team from the Brookhaven National Laboratory has been investigating for some months the problems involved in establishing the Manila center. The team's report stated that the center, "is an entirely feasible enterprise, capable of rendering a valuable service to the progress and development of the area." However, the report recommended, among other things, that the nations involved agree in advance on a formula for sharing future operating costs.

The $20 million for the project will come out of the special $100 million Asian regional development fund set up by Congress in the 1955 Foreign Aid Bill. The money is available for 3 years.

IGY Upper Atmosphere Research

Three special National Science Foundation grants of more than $325,000 have been awarded to Stanford University scientists for radio investigations of the upper atmosphere during the International Geophysical Year. The work will involve a network of 24 radio-radar stations extending from the Arctic Circle in the north to Little America near the South Pole. Allan M. Peterson, Robert A. Helliwell, and O. G. Villard, Jr., all of the Radio Propagation Laboratory, are the recipients of the NSF awards.

Peterson's research is related to the IGY's aurora and airglow studies. He will establish and direct the work of 13 ionospheric "scatter-sounding" stations ranging from Greenland down both coasts of North America. Other stations will be located in Central and South America and in Australia. Unusual equipment at the stations will provide a radarlike picture of invisible ionized cloud effects in the upper atmosphere for 1000 miles or more around each post.

Helliwell's work, part of the IGY's ionospheric physics program, has to do with the curious "whistler" sounds believed caused by lightning flashes which generate radio signals that travel far out into space. There will be ten stations located in the Northern and Southern Hemispheres participating in this research. Villard's grant will be used for radar meteor investigations in Little America.

Free Radicals Research Program

A 3-year program of basic research on free radicals has been undertaken by the National Bureau of Standards. The object of the program is to increase fundamental knowledge of the formation, properties, and storage of these highly reactive molecular fragments. The series of experimental and theoretical investigations is receiving support from the Department of Defense through the Office of Ordnance Research, U.S. Army.

Over-all direction and coordination of the work is centered in a Free Radicals Research Section recently established for this purpose. Herbert P. Broida, who has been named chief of the new section, will serve as technical coordinator for the entire program; Arnold M. Bass is assistant chief of the section.

To encourage broad dissemination of the information obtained in the program, and also to minimize interference with other established projects at the Bureau, participating scientists are being drawn largely from other institutions. Approximately half of the technical staff for the free radicals research program will be on loan from industrial research laboratories, working under an unusual cooperative plan. Others will come from universities and various government agencies. It is expected that the work of this central research group will be continued and expanded in many of the industrial laboratories after termination of the present program.

A technical data center is being set up so that free radical research at other laboratories, both in the United States and abroad, may be closely followed. Other activities serving to knit together the various research projects making up the program will include weekly colloquia and a general conference now being planned for mid-1957.

Male Fertility Index

A new index to fertility in males has been discovered by scientists of the Southwest Foundation for Research and Education (San Antonio, Tex.). In studies of thoroughbred horses conducted at the institution's branch in Lexington, Ky., it was found that the sulfhydryl content of seminal fluid provides an index to the ability of the semen to induce pregnancy.

When the sulfhydryl content is high, there is a reduction in the capacity of the sperm to maintain its ability to move. This is associated with failure to cause pregnancy. The sulfhydryl concentration varies from day to day. Studies are now in progress to determine whether or not this new index is applicable to human beings.

Pioneer in X-ray Therapy

Emil H. Grubbe, probably the first American to treat a patient with x-rays, has undergone his 90th operation for cancerous burns resulting from his own early exposure to radiation. Sixty years ago, in Philadelphia, Grubbe gave x-ray therapy to a woman suffering from cancer. This was only a few months after Wilhelm Roentgen, the German physicist, had announced a method for generating x-rays.

Now 81, and living in retirement, Grubbe has lost his left hand, nose, upper lip, and most of the right side of his face. His right hand is enfeebled. He

must repeatedly return to the hospital for further surgery. Since 1896, Grubbe has taught 7000 other physicians how to use x-rays.

News Briefs

■ Homosexual patterns in our society will be discussed by Margaret Mead, noted anthropologist and AAAS board member, and Max Lerner, author and *New York Post* commentator, on 12 Jan. over WRCA-TV (New York area). This will be the third broadcast on homosexuality by the NBC program series "The Open Mind." The first two were last August, and it is reported that substantial pressure was brought to bear on NBC to cancel the second program because of sensitivity about public discussion of such a subject.

■ The Council for Scientific and Industrial Research, Union of South Africa, has stationed a permanent scientific liaison officer in Germany, thus establishing the third South African Scientific Liaison Office overseas; the other two are in London and Washington. J. P. Van Zyl is the scientific adviser who heads the new office, which is in Cologne.

Scientists in the News

The American Institute of Mining, Metallurgical and Petroleum Engineers has announced the names of 14 men who will receive awards at the organization's annual meeting in New Orleans, 24–28 Feb.:

ANDREW FLETCHER, president of the St. Joseph Lead Company, Charles F. Rand medal.

RUSSEL B. CAPLES, president of the Anaconda Aluminum Company, James Douglas medal.

JOHN E. BRANTLY of Cocoa, Fla., retired founder of the American Association of Oil Well Drilling Contractors, Anthony F. Lucas medal.

LEO F. REINHARTZ, who recently retired as vice president of the Armco Steel Corporation, Benjamin F. Fairless award.

ANTOME MAR GAUDIN, professor of mineral dressing, Massachusetts Institute of Technology, Robert H. Richards award.

ARTHUR TIX of Bochumer, Germany, works director of Gusstahalwerk Bochumer Verein, A.G., Robert W. Hunt medal.

MOHAMMED MORTADA, senior engineer of the Magnolia Petroleum Company, Rossiter W. Raymond award.

PAUL GORDON of the Institute for the Study of Metals, Chicago, Mathewson medal.

RAYMOND W. SUNDQUIST, assistant division superintendent of blast furnaces, United States Steel Corporation, J. E. Johnson, Jr., award.

JOSEPH L. GILLSON, geologist for E. I. du Pont de Nemours and Company, D. C. Jackling award.

R. C. BELL, senior research engineer, and G. H. TURNER and E. PETERS, research engineers, all of the Consolidated Mining and Smelting Company of Canada, Ltd., Extractive Metallurgy Division award.

LOUIS A. PANEK, mining methods research engineer, U.S. Bureau of Mines, Robert Peele award.

KARL K. DARROW, internationally known author and lecturer on physics, retired from the technical staff of Bell Telephone Laboratories on 30 Nov. after nearly 40 years of service with the Bell Telephone System. He joined the Western Electric Company as a research physicist in 1917 and became a member of Bell Laboratories on its incorporation in 1925. He had previously completed extensive studies in mathematics and physics at the universities of Chicago, Paris, and Berlin. He received the B.S. and Ph.D. degrees from the University of Chicago in 1911 and 1917, respectively.

At Bell Laboratories he has devoted a major portion of his time to the study and interpretation of current and historical scientific information for his colleagues, to keep them informed of developments in fields of science related to their research activities.

As a result of his extensive writing and lecturing, the influence of Darrow's work in interpreting science has extended outside the Bell System. He has published eight books and more than 200 articles. In addition, Darrow has served as visiting professor at the University of Chicago, Columbia University, Smith College, and Stanford University.

He has long been active in the American Physical Society and has been its secretary since 1941. He is also a member of the American Philosophical Society, of which he was a councilor for 4 years. He has been a member of the French Physical Society for many years and served for a term on its council. He is also a member of the Physical Society of London and of the International Union of Pure and Applied Physics, which he served as vice president from 1947 to 1951.

In recognition of Darrow's contributions to science, the University of Lyons in 1949 granted him the honorary degree of doctor of science. In 1951 the French Legion of Honor awarded him its decoration, with the rank of Chevalier, for "services rendered to the international relations of science and to the cultural relations between France and the United States."

After his retirement, Darrow plans to continue his work with the American Physical Society, with frequent intervals of foreign travel. He also intends to continue, through his writings and lectures, to assess and interpret the latest discoveries in the physical sciences.

GEORGE F. REDDISH, chief bacteriologist of the Lambert-Hudnut Division of the Warner-Lambert Pharmaceutical Company, St. Louis, Mo., has received the 1956 achievement award of the Chemical Specialties Manufacturers' Association for outstanding work in the fields of public health, disinfection, and antisepsis.

JOHN B. MACDONALD, formerly chairman of the division of dental research and professor of bacteriology at the University of Toronto, has been named director of the Forsyth Dental Infirmary for Children and professor of oral microbiology in the Harvard School of Dental Medicine. Macdonald's selection is the first joint appointment made by the two institutions since their affiliation in May 1955. Macdonald succeeds the late HOWARD M. MARJERISON as director of the Forsyth Dental Infirmary.

Three appointments to the staff of the John Jay Hopkins Laboratory for Pure and Applied Science (San Diego) have been announced by the General Atomic Division of General Dynamics Corporation: THEODORE B. TAYLOR, a theoretical physicist formerly with Los Alamos Scientific Laboratory; HAROLD A. THOMAS, a physicist who was chief of the Radio Standards Division of the National Bureau of Standards, and LLOYD ZUMWALT, a physical chemist who during the past year was operations vice president of the Nuclear Science and Engineering Corporation.

WILLIAM S. McCANN, chairman of the department of medicine at the University of Rochester School of Medicine and Dentistry since the school was opened in 1925, will become emeritus professor on 1 July 1957. President of the Association of American physicians in 1952, McCann has served as deputy chairman of the Committee on Medical Sciences of the Research and Development Board, Department of Defense; chairman of the American Board of Internal Medicine; member of the Naval Research Advisory Committee and of the Committee on Medicine of the National Research Council; vice

president and member of the council of the American Society for Clinical Investigation; and consultant for the Veterans Administration in Area 1 (New York and New England).

In 1949, the Cornell University Medical School Alumni Association gave him its first annual award of distinction "in recognition of his notable achievements in medical science and education and for his dynamic influence in the art and practice of medicine." In 1950, McCann's past and present students took part in an all-day symposium in his honor celebrating his 24th anniversary as Charles A. Dewey professor of medicine.

McCann is noted for his research on the relation between heart and lung diseases. He pioneered in work on silicosis and has made important contributions to the overcoming of that disease as a major health problem in industry.

In World War II, McCann served with the U.S. Naval Reserve from 1941 to 1944, going on active duty in December 1942 with the rank of commander. He was chief of medicine and later executive officer at the U.S. Naval Hospital at the Naval Operating Base at Norfolk, Va. Subsequently he had 8 months of sea duty aboard the U.S.S. *Refuge,* the Navy's largest hospital ship, as chief of clinical activities. He saw service in the invasion of southern France, and also in North Africa, Italy, England, and Iceland. During these actions, the *Refuge*'s medical staff took aboard 2500 wounded, and only two deaths occurred. McCann was promoted to captain in 1944.

McCann graduated from Ohio State University in 1911 and received his M.D. degree at Cornell University Medical School in 1915. His wife, Dr. Gertrude Guild Fisher McCann, who died 15 Nov. 1956, was his classmate. Their daughter, Dr. Elizabeth McCann Adams (who is the wife of Dr. Hugh R. Adams of Cooperstown, N.Y.) and their son, Dr. William P. McCann, also are graduates of Cornell Medical School.

McCann is a fellow of the AAAS, and he holds honorary degrees from Ohio State University and Hobart College.

ORLAN W. BOSTON, professor emeritus of mechanical and production engineering at the University of Michigan, and WILLIAM W. GILBERT, former professor of production engineering, who is now with the General Electric Company, received the Blackall machine tool and gage award of the American Society of Mechanical Engineers during the society's recent annual meeting. They were honored for a technical paper on "Forces and power required to turn aluminum and seven alloys," which they published this year.

CHARLES P. HUTTRER, formerly executive secretary in the Division of Research Grants, National Institutes of Health, Bethesda, Md., has joined the staff of the Cancer Chemotherapy National Service Center, National Cancer Institute, as assistant chief in charge of two sections, one on documentation, information, and publications, and one on program analysis and planning. He will also serve as liaison with the NIH Division of Research Grants.

CRAIG M. CRENSHAW has been appointed chief scientist, Signal Corps Research and Development, U.S. Army. He was formerly director of the Physical Sciences Division, Evans Signal Laboratory, Fort Monmouth, N.J.

ABOLGHASSEM GHAFFARI, professor of mathematics at the University of Teheran (Iran), has joined the applied mathematics division of the National Bureau of Standards. As a member of the mathematical physics section, he will devote his time to studies involving theoretical aspects of fluid dynamics and nonlinear vibrations. His principal areas of research have involved differential equations and fluid dynamics. Ghaffari, who is a member of the Princeton Institute for Advanced Study, has lectured at a number of universities in this country, including Columbia, Harvard, and Princeton and the Massachusetts Institute of Technology.

THOMAS S. BUCHANAN, since 1951 director of research for the International Cooperation Administration's agricultural development program in Liberia, has been appointed assistant chief, Division of Forest Disease Research, Washington office of the U.S. Forest Service. He replaces MARVIN E. FOWLER, who has transferred to the Northeastern Forest Experiment Station at Upper Darby, Pa., to serve as chief, Division of Forest Disease Research.

HARRIS ROSENKRANTZ of the Worcester Foundation for Experimental Biology in Shrewsbury, Mass., has received the 1956 Admiral Ralph Earle award of the Worcester Engineering Society. He was recognized for his work in the development of infrared analytical techniques and interpretation of infrared absorption spectra. Rosenkrantz is the first biochemist to win this award.

FRANK P. GREENSPAN, formerly manager of organic research and development of the Becco Chemical Division, Food Machinery and Chemical Corporation, has been named director of development of the new FMC Organic Chemicals Division. This division makes and sells all plastics and organic chemicals not directly linked with FMC's Westvaco, Becco, Fairfield, and Niagara divisions. Greenspan will move to New York soon to take up his new post.

C. HAROLD FISHER, chief of the U.S. Department of Agriculture's Southern Utilization Research Branch, New Orleans, La., has won the 1956 Southern Chemist award of the American Chemical Society's Memphis (Tenn.) section. The gold medal, given annually for distinguished service to the profession of chemistry in the southern states, was presented to Fisher on 7 Dec. during a banquet in Memphis that was a highlight of the ACS Southwide Chemical Conference.

WINFRED O. MILLIGAN, professor of chemistry at Rice Institute, and director of research for the Robert A. Welch Foundation, was also honored at the banquet. He received the 1956 Southwest award of the ACS.

Col. LLOYD E. FELLENZ has replaced Col. DONALD H. HALE as chief of the Army Chemical Corps Chemical Warfare Laboratories at Edgewood, Md. Hale has retired from the Army and is now an executive with the Food Machinery and Chemical Corporation, San Jose, Calif. Fellenz has served with the War Plans Division, the Industrial Engineering Division, and the Chemical Corps Board, in addition to having commanded a chemical group and served as chemical officer with the Continental Army Command, Fort Monroe, Va.

Recent Deaths

SAMUEL T. ARNOLD, Providence, R.I.; 64; provost of Brown University and former chairman of the chemistry department; 12 Dec.

JAMES BIRNHOLZ, Putnam Valley, N.Y.; 86; former vice president of the General Electric Company of Germany; 12 Dec.

ALMENA DAWLEY, Flourtown, Pa.; 66; founder and retired associate director of the Child Guidance Clinic of Philadelphia; 12 Dec.

EVERETTE L. DEGOLYER, Dallas, Tex.; 70; petroleum geologist and chairman of the board of the *Saturday Review;* 14 Dec.

W. A. NEWMAN DORLAND, Chicago, Ill.; 92; editor of the *American Illustrated Medical Dictionary;* 11 Sept.

D. M. HETLER, Missoula, Mont.; 60; professor of bacteriology and chairman of the department at Montana State University; early September.

CHARLES C. HUNTINGTON, Columbus, Ohio; 83; retired professor and first chairman of the department of geog-

raphy at Ohio State University; 29 Nov.

JOHN T. MILLEN, Detroit, Mich.; 72; retired director of the Detroit Zoo; 7 Dec.

ARTHUR S. PEARSE, Durham, N.C.; 79; retired professor of zoology at Duke University; 11 Dec.

DONALD S. PISTON, Fresno, Calif.; 56; head physicist at the Twining Laboratories; 30 Sept.

HORACE S. UHLER, Meriden, Conn.; 84; professor emeritus of Physics at Yale University; 6 Dec.

FORBES B. WILEY, Granville, Ohio; 76; professor emeritus of mathematics at Denison University; 14 Dec.

Education

■ The National Science Foundation has awarded $303,000 to the Massachusetts Institute of Technology to support a 2-year study of physical-science teaching in secondary schools. Some of the foremost physical scientists of the United States will serve on an MIT-sponsored committee, under the direction of Jerrold R. Zacharias, professor of physics at MIT.

The committee will make an intensive effort to improve presentation of high-school subject matter in the physical sciences. The group will examine all possible means of improving instruction in the area, realizing that this may lead to preparation of new textbooks, new laboratory manuals, new experimental equipment, new teaching techniques, and extensive use of films. The committee will be aided by leading members of the faculties of the California Institute of Technology, the University of Illinois, and Cornell University, as well as by representatives from the Bell Telephone Laboratories, who will attempt to outline materials necessary to accomplish the objectives of the project.

James R. Killian, Jr., president of M.I.T., will be chairman of a larger group, composed of scientists, high-school administrators and teachers, representatives of state departments of education, and others, to advise, and make recommendations on problems of acceptance and distribution.

■ Steps involved in establishing and operating an educational television station are outlined in a new booklet just published by three national organizations involved in the development of educational television in this country: the Educational Television and Radio Center, Ann Arbor, Mich.; the Joint Council on Educational Television, Washington, D.C.; and the National Association of Educational Broadcasters, Champaign–Urbana, Ill. Entitled *Educational Television for Your Community,* the booklet gives costs of establishing an educational station, offers case studies of present stations, and indicates staff needs for ETV units. Copies of the booklet may be obtained by writing to the Educational Television and Radio Center, Ann Arbor, Mich.

■ Each year, under the program of the International Association for the Exchange of Students for Technical Experience, U.S. industries are asked for summer industrial placements for foreign science and engineering students. The request is made by the Institute of International Education as the administering agency for the IAESTE program. Placements include a maintenance allowance for the foreign student and a nominal administrative fee to cover program costs. Since the IAESTE program is reciprocal, the number of placements offered by American business to foreign students determines in general the number of American students who will have the opportunity to train abroad.

Last summer, 45 U.S. firms received 75 students from abroad, while 58 American students of science and engineering trained in 13 European countries. The U.S. IAESTE National Committee met early in the fall at the Institute of International Education to evaluate the 1956 program and to make plans for increased activity in 1957.

Reports on the program indicate that American participation increased markedly during the year since the committee's establishment. Although the increase is a substantial one, American participation is still far below that of the leading European countries. The committee voiced the hope that there would be even greater participation in the program by American industry in 1957.

Under this program, in which 22 countries participate, students are sent abroad for training in industry during their summer vacations. In 1956, more than 2500 industries in these countries provided training for more than 5700 visiting students from other member countries.

U.S. colleges are asked to nominate American students of engineering and the sciences who wish practical training abroad. Each applicant must have completed his third year of study, must have had practical experience in this country, and must be able to pay for his international travel. Endorsement by an official of the candidates' schools is required with regard to the students' general and technical qualifications. The 58 U.S. students who trained abroad in 1956 represented 24 American colleges.

The 75 foreign students who trained with American firms last summer came from the following European countries: Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Italy, the Netherlands, Norway, Spain, Sweden and Switzerland. The 58 American students trained in these same countries.

A pamphlet describing the program is available from the Institute of International Education. Industries interested in this exchange are advised to address their requests to: Secretary U.S. IAESTE Committee, Institute of International Education, 1 E. 67 St., New York 21, N.Y.

■ A gift of $500,000 toward founding a medical library has been received by the Albert Einstein College of Yeshiva University. The donation came from the D. S. and R. H. Gottesman Foundation in memory of the late D. Samuel Gottesman, who was president of Gottesman and Company, pulp and paper merchants, and of Central National Corporation, investment bankers.

Construction of the three-story library building, which will cost $1 million, will begin early next spring on the medical school's 16-acre site in the Bronx. It is scheduled to be completed before the opening of the college's third academic year in September 1957.

The D. Samuel Gottesman Library, as it will be known, will have shelving for 200,000 volumes. The building will include a reading room that will accommodate 150 people, reading corrals, special study-typing rooms, and a current periodical room, as well as two below-level stack floors for books and periodicals.

The library will serve as a reference center for physicians in the Bronx-Westchester area. It will also be the repository of a historical collection dealing with the contributions of Jewish physicians and scientists to the development of medical knowledge.

Grants, Fellowships, and Awards

■ Seven national awards in engineering education will be given by the American Society for Engineering Education at its 1957 annual meeting at Cornell University, 17–21 June. Competitions for all the awards are now open, and nomination blanks are ready for distribution. The seven awards are as follows:

1) The Lamme award, given annually to an engineering educator for distinguished achievements contributing to the advancement of the profession. This is the Society's oldest award and its highest honor.

2) The George Westinghouse award, an annual $1000 prize for distinguished contributions to teaching engineering students. The Westinghouse Award is especially intended to encourage younger men who show superior teaching ability.

3) The Vincent Bendix award, a gold medal given annually for top achieve-

ment in engineering research in colleges and universities. It is to recognize contributions through original research, research administration, leadership influencing the productive research of others, and the effective application of research results to the advancement of engineering education.

4) The Curtis W. McGraw research award to honor young staff members for contributions through engineering college research. This $1000 prize, to be given for the first time next year, is to recognize outstanding early research achievements and to encourage the continuance of such activity in the future.

5) The James H. McGraw award in technical institute education is an annual prize of $500 presented for established achievement in technical institute education—teaching, administration, publications, and other forms of leadership.

6) The president's awards to young engineering teachers, given annually for papers written by young engineering teachers on a phase of engineering education. The contest seeks to encourage the participation of young teachers, 36 years or younger, in the problems of engineering education. Prizes of $200 and $100 are given for the two-top-ranking papers.

7) The engineering drawing award of a certificate for distinguished service by a member of the society's engineering drawing division. The qualifications include a record of successful teaching, improvement of the tools and conditions for teaching, scholarly contributions to engineering drawing, and service to the Division.

The society's awards are given to winners selected, in each case, by special committees assigned to study the records of each nominee. Further information and blanks for nominations are available from the secretary of the society, Prof. W. Leighton Collins, University of Illinois, Urbana, Ill.

■ The Earth Sciences Program of the National Science Foundation is now receiving proposals for research grants that will be made in June and July 1957. The deadline date for receipt of applications is *8 Feb. 1957*.

There are no formal application blanks, but an NSF pamphlet describes application procedure, including an outline of the information needed in a proposal. This pamphlet may be obtained by writing to the National Science Foundation, Washington 25, D.C., Attention: Earth Sciences Program.

■ The mycological herbarium of Dr. Gertrude Simmons Burlingham, consisting of some 10,000 collections of *Russula, Lactaria,* and other genera of fleshy Basidiomycetes, and her library of books and pamphlets on fungi were bequeathed to the New York Botanical Garden in 1952. Under the will of her friend and executrix, Miss Gertrude Sturges, the Garden is to receive an endowment for the Gertrude S. Burlingham scholarship in mycology, assuring the continuation of this scholarship first offered in 1956. No appointment will be made for 1957, but under present plans the scholarship will subsequently be awarded annually.

■ The National Science Foundation will award individual grants to defray partial travel expenses for a limited number of American scientists who wish to participate in the 30th session of the International Statistical Institute and in the Congress of the International Union of the Scientific Study of Population. These two congresses are scheduled to meet in Stockholm, Sweden, 8–15 Aug. 1957.

Application blanks may be obtained from the National Science Foundation, Washington 25, D.C. Completed application forms must be submitted by *1 Mar. 1957*.

In the Laboratories

■ Vitro Engineering Division of New York, a division of the Vitro Corporation of America, has received a contract for engineering services on a CP-5 nuclear reactor research facility to be built in Milan, Italy. The reactor will be a heavy water plant using enriched uranium as fuel. It will be of the same type as the CP-5 reactor operated by the Atomic Energy Commission and Argonne National Laboratory at Lemont, Ill.

■ The 26th session of the Norelco X-ray Diffraction School for research and industrial registrants who can visit the New York City area will be held at the plant of North American Philips Company, Inc., 750 S. Fulton Ave., Mount Vernon, N.Y., during the week of 4–8 Feb. Registration for the school will be limited to 125 for the first 4 days and to 150 on Friday, the day devoted to actual application problems when guest speakers discuss methods currently in use by researchers and industrial plants. It is recommended that those planning to attend the February meetings make their reservations at the earliest possible date. There is no registration fee.

■ On 20 Nov. the library of the Ortho Research Foundation, Raritan, N.J., was dedicated to Carl G. Hartman, director emeritus of the foundation. On this occasion, George W. Corner delivered an address on "Reprints, their use and abuse."

Miscellaneous

■ *Tetrahedron,* an international journal of organic chemistry, has been announced by the chairman of the honorary editorial board, Sir Robert Robinson of Great Missenden, Bucks., England. Contributions will be printed in English, French, or German. Original memoirs of an experimental or theoretical nature will be accepted, in addition to preliminary communications and short presentations of stimulating ideas. Longer papers describing an extended investigation will be welcomed. It is hoped that this type of longer paper will make it easier for the reader to become acquainted with the results of the work of his colleagues in other countries.

The international character of the new periodical will be emphasized, for the publication is not intended to compete with existing national journals; the aim will rather be to complement them. It is hoped that a special feature will be the publication in English, French, or German of outstanding research work that has already appeared in another language, such as Russian, Czech, Hungarian, Chinese, or Japanese. In this connection, mere translations are not contemplated but rather a synthesis of older matter with additions of newer results.

Tetrahedron is intended to cover all aspects of organic chemistry, whether theoretical or practical, analytic or synthetic, physical or biological. Papers on applied chemistry that have a pure organic chemical content will be acceptable in many cases.

Honorary regional editors are as follows: Dr. M. S. Kharasch, Department of Chemistry, University of Chicago, Chicago 37, Ill., U.S.A.; Prof. R. H. Martin, Laboratoires de Chimie Organique, Université Libre de Bruxelles, 50 Ave. F. D. Roosevelt, Brussels, Belgium; and Academician A. N. Nesmeyanov, Academii Nauk SSSR, Bolshaya Kaluzkskaya 14, Moscow, U.S.S.R. The executive editor is Emeritus Professor H. Stephen, O.B.E., D.Sc., F.R.I.C.

■ A cross section of the recently discovered pine tree that probably attained the greatest age of anything that ever lived on earth [*Science* **124**, 884 (2 Nov. 1956)] has been offered to the American Museum of Natural History for exhibition in the Hall of North American Forests that is to be opened late next year. The 4000-year old bristlecone pine from which the section will be cut was discovered by Edmund Schulman, dendrochronologist of the University of Arizona Laboratory of Tree-Ring Research, who has announced his intention to present the section to the museum.

Reports

Proteolytic Enzyme Activity in Irradiation-Sterilized Meat

The recorded formation of tyrosine crystals in the storage of irradiation-sterilized raw meat (*1*) is indicative that a general proteolysis occurs in irradiated meat samples (tyrosine is the least soluble of the amino acids). The principal proteolytic enzymes present in beef muscle have been identified as cathepsins (*2*). It has been reported that an irradiation dose of 1.6 million rep inactivates only 50 percent of the proteinase activity in samples of beef muscle (*3*).

Additional pertinent information is provided by data taken from three different investigations in the Radiation Preservation of Foods Project at the Quartermaster Food and Container Institute for the Armed Forces (*4*).

Extensive crystal formation gave a very unappetizing appearance to all samples of irradiated pork tenderloin that had been stored for 3 months at 100°F. Samples stored at 72°F had an increased free amino acid content in the fluids that were squeezed from the meat, but enzyme activity had not produced sufficient concentration of tyrosine to form crystals. Variables in the study were an initial freezing or wet-ice pack before irradiation, an irradiation dose of 2 or 3 million rep, and storage at either 72° or 100°F.

Table 1 shows the results obtained from paper-chromatographic, amino-acid analyses of residue fluids after steam-distillation of various samples of ground beef. The preirradiation heat treatment was based on conditions determined to be sufficient for inactivating catalase by heat and consisted of heating the meat in a steam retort and holding it for 10 minutes at an internal temperature of 160°F. The results show that proteolysis has been inhibited in the meat in which the enzymes were heat-inactivated.

One milliliter of 1-percent solutions of ascorbic acid or of cysteine (known cathepsin activators) and 1 ml of copper sulfate or of hydroquinone (cathepsin inhibitors) were added to 200-g samples of ground beef prior to irradiation at 3, 6, or 12 million rep. Some samples were stored at 76°F, and the rest at 100°F.

No tyrosine crystal formation was evident in sample cans that were opened after 3 months' storage. After 7 months' storage at 100°F, however, crystals were found in the 3-million-rep-dose cans containing the added cathepsin activators. No crystals were observed in the cans used to test the other variables. These results may be interpreted as follows:

1) The rate of enzyme activity is accelerated at the higher storage temperatures.

2) The inhibition of enzyme activity at greater doses of irradiation may be due to destruction of the enzyme activators. More likely, however, this work confirms the report (*3*) that proteinases exhibit greater resistance than bacteria to inactivation or destruction by irradiation. The effect is opposite to that encountered in heat sterilization of foods where the amount of heat necessary to inactivate enzymes is less than that required to destroy microorganisms.

3) A supplementary confirmation is made of cathepsins as the principal proteolytic enzymes present in beef muscle.

The data cited show that prolonged storage and storage at elevated temperatures will destroy meat structure and probably develop a bitter taste in it (most L-amino acids are bitter). The necessity for inactivation of the proteolytic enzymes is indicated, therefore, if irradiation-sterilized meat is to become an acceptable food product.

Table 1. Semiquantitative paper-chromatographic, amino-acid analyses of residue fluids from steam distillations of equal weights of fresh and irradiated samples of ground beef. The presence of free amino acids is indicated by +.

Treatment	Presence of free amino acids	
	Before storage	After storage
Fresh	+	
Irradiated (2×10^6 rep)	+	++++*
Irradiated (3×10^6 rep)	+	++++*
Preirradiation heat-treated (3×10^6 rep)	+	+†

* Stored 3 months at 76°F; † stored 5 months at 76°F.

MAURICE P. DRAKE, J. W. GIFFEE, JR., ROBERT RYER III, HUBERT HARRIMAN
Food Laboratories, Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois

References and Notes

1. G. B. Pratt and O. F. Ecklund, *Food Technol.* 10, No. 10, 496 (1956).
2. A. K. Balls, *Ice and Cold Storage* 41, No. 4, 85 (1938).
3. D. M. Doty and J. P. Wachter, *J. Agr. and Food Chem.* 3, 61 (1955).
4. This report is paper No. 681 in a series of papers approved for publication. The views or conclusions are ours and are not to be construed as necessarily reflecting the views or endorsement of the Department of Defense. A fuller account of the several studies on which this report is based is in preparation.

11 October 1956

Effect of Ionizing Radiation on Rust Reaction in Plants

Studies on the nature of resistance of plants to rust diseases have long been hampered by the fact that the rust fungi are obligate parasites. One approach to the problem is the alteration of the disease reaction by manipulation of environment (*1*) or by chemical treatment (*2*) of the host plant, followed by appropriate physiological or biochemical analyses of the change induced. Recently, ionizing radiation (*3*) has been investigated as a possible therapeutic agent and as a tool for studying the vascular wilt disease of tomato, which is caused by the heterotrophic fungus, *Fusarium oxysporum* f. *lycopersici*. This report (*4*) records the effects of chronic gamma- and acute x-ray treatments on the host-parasite interaction in several rust diseases: flax rust (*Melampsora lini*, race 1); wheat stem rust (*Puccinia graminis tritici*, races 15B and 111); oat stem rust (*P. g. avenae*, race 7A) and crown rust of oats (*P. coronata avenae*, race 202).

For chronic gamma treatments, seedlings grown to the first- or second-leaf stage in plastic pots were exposed to radiation from a 9.4-c Co^{60} source in the greenhouse. Dose, dose rate, stage of growth, and time of inoculation were the main variables. For x-ray treatments, the seedlings were grown in a mixture of loose soil and peat, removed, washed and enclosed in plastic film for irradiation. Plants were inoculated immediately after irradiation and transplanted to soil or grown in liquid nutriculture. Lead shielding and x-rays were used for partial-plant exposures.

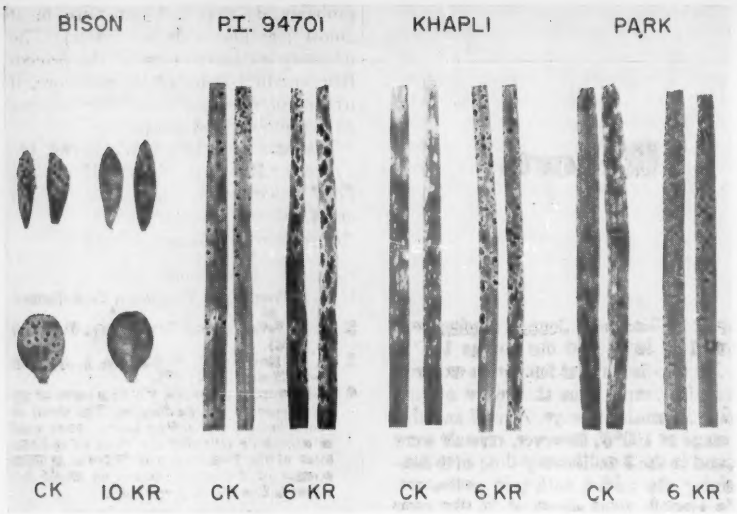

Fig. 1. Comparison of rust infection types produced on nonirradiated (*CK*) and gamma-irradiated seedlings of flax (Bison), wheat (P.I. 94701, Khapli), and oats (Park). With wheat and oats, irradiation preceded inoculation.

Gamma radiation did not noticeably affect the rust reaction of 16 resistant flax varieties that were inoculated before or after application of a 10-kr chronic dose. The reaction of two normally susceptible varieties, Bison and Williston Brown, appeared resistant when inoculation preceded irradiation (Fig. 1). In this case, the fungus renewed growth within 3 days after termination of the exposure. Subsequent experiments with x-rays proved that the inhibitory effect was on the parasite rather than on the host; a 10-kr acute dose was lethal to more than 90 percent of 1-day-old infections.

Table 1. Rust reaction of seedlings of wheat and oat varieties exposed to 6 kr of gamma radiation before inoculation.

Variety	Rust reaction*	
	Control	Irradiated
Wheat inoculated with race 15B†		
St 464 (191365)‡	0;	0;
Khapli (4013)	0; to 1 −	0; to 3
Kenya Farmer (12880)	1	3 to 4
P.I. 94701	3 −	4
Mindum (5296)	4	4+
Oats inoculated with race 202		
Saia (7010)	0	0
Park (6611)	1	3 to 4
Markton (2053)	4	4
Oats inoculated with race 7A		
Garry (6662)	1	1 to 3
Park (6611)	1	3±
Markton (2053)	4	4+

* Rust reaction class symbols 0, 0;, and 1 denote relative degrees of resistance; symbols 3 and 4 represent moderate and complete susceptibility, respectively; plus and minus signs indicate the upper and lower limits, respectively, of each type.
† For specific assignments of physiologic races 15B, 202, and 7A, see text.
‡ P.I. or C.I. numbers, in parentheses, represent Plant Introduction and Cereal Investigations accession numbers, U.S. Department of Agriculture.

Radiation before inoculation produced no appreciable change in infection type of wheat or oat plants in some resistant varieties, while plants of other varieties became less resistant in varying degrees (Table 1). No case of increased resistance was observed, the trend of change being invariably toward susceptibility. Moderately resistant varieties such as P.I. 94701 appeared particularly amenable to a breakdown of resistance, although a resistant variety such as Kenya Farmer underwent an almost complete change from resistance to susceptibility. The change in reaction on wheat and oats, as contrasted with the inhibitory effect on the growth of flax rust, was clearly due to an alteration of the host and not of the fungus. This was confirmed by the fact that the response occurred whether the full dose preceded inoculation or was divided before and after inoculation. The effect persisted as long as the leaves remained alive.

Chronic irradiation begun 1 day after inoculation was less effective in breaking resistance, probably because such an effect required the revival of fungus growth already stagnated by host-cell necrosis. Approximately 5 kr of chronic gamma radiation, applied at a rate of 1 kr/day, consistently induced distinct changes in the host response. The effective dose range was more readily defined in the acute x-ray treatments. Breakdown of rust resistance could be initiated with as little as 1.5 kr of x-rays and would reach a maximum with approximately 3 kr. The corresponding doses for inhibition of leaf development were 0.5 kr and 1.5 kr; at the latter dose, stunting of the roots and formation of root-tip nodules also became apparent.

Plant injury was not necessarily associated with rust reaction, for some sources of rust resistance, especially in wheat, were not altered, while others responded to varying degrees. This suggests differences in the radiation stability of the physiological processes normally involved in rust reaction, or the interaction of these with other processes not ordinarily related to rust development. A degree of specificity in the nature of the physiological change also is indicated by the difference in the rust-reaction "spectrum" of resistant varieties when tested with more than one physiologic race of the fungus. In wheat varieties that are normally resistant to the widely pathogenic race 15B and the weakly pathogenic race 111, the shift toward susceptibility on irradiated plants was considerably greater with race 15B than with race 111.

Partial-plant irradiation tests revealed the crown—particularly the shoot apex—as the major radiosensitive site. Irradiation of this site was not only responsible for stunting of the leaves but also initiated a portion of the physiological modification favoring rust development on the leaves. Exposure of both roots and crown permitted maximum expression of relative susceptibility, although exposure of the roots alone did not yield decisive changes. Leaf treatments alone produced no injury or significant reduction of resistance.

The physiological basis of the modified rust reaction is not known, although the association of the shoot apex suggests a possible involvement of growth-regulating substances similar to that described for tomato wilt by Waggoner and Dimond (*3*).

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13 September 1956

Quinine Calibration of the Aminco-Bowman Spectrophotofluorometer

Recently, spectrophotofluorometers have been developed that make possible the scanning of excitation and fluorescent spectra in the visible and ultraviolet regions. They can thereby be used for the identification and quantitative assay of organic compounds (*1*). Such instruments present the most sensitive method devised to date for the measurement of 5-hydroxyindole compounds (*2*), which are of interest in psychopharmacology (*3*) and in diagnosis of carcinoid tumor (*4*).

To date, we know of no data that have been reported on scanning spectrophotofluorometric measurements of quinine. It is of interest, therefore, to present such data, for quinine is a compound frequently used as a standard in the calibration of instruments of this type (*5*).

The recently available Aminco-Bowman spectrophotofluorometer (*6*) was used in this study. Calibration of this instrument was made with N.F. quinine alkaloid (*7*) as the reference compound. Using a quinine solution of 0.1 μg/ml in 0.1*N* H_2SO_4, we determined the excitation (activation) and fluorescent spectra by the method described in the instruction manual for the Aminco-Bowman spectrophotofluorometer (*8*). Quinine samples from two other sources gave similar results.

Several peaks were observed in both the activation and fluorescent spectra for all three samples tested. Activation peaks occurred as follows: at 265 mμ, a prominent peak; at 365 mμ, a maximum peak; at 455 mμ, a scatter peak; at 510 mμ and 750 mμ, occasional harmonics of the 265-mμ and 365-mμ peaks, respectively. These were the observed, uncorrected values. Corresponding fluorescence peaks occurred as follows: at 360 mμ, a scatter peak; at 450 mμ, a maximum peak. Thus the activation maximum was at 365 mμ (uncorrected) and the fluorescence maximum was at 450 mμ. These peaks checked to within 5 mμ on repeated tests.

Serious question exists whether 365 mμ is the true activation maximum for quinine. Other investigators using the Aminco-Bowman instrument have reported activation maxima similar to ours within 5 mμ (*9*). Activation maxima obtained on the afore-mentioned quinine samples with the Farrand recording spectrofluorometer model C occurred at 350 mμ (*10*). Absorption maxima that we obtained with the same samples on the Beckman DU spectrophotometer occurred at 348 mμ to 350 mμ. Since activation maxima should theoretically be identical with absorption maxima (*11*), this would prejudice evidence in favor of 350 mμ being the more precise activation maximum. Until more is known about the nature of the chromatic response to the activation process, it is in order to consider a correction factor of −15 (correct to within 5 mμ) for activation spectra obtained on the Aminco-Bowman instrument.

There is no question whether 450 mμ is the true fluorescence maximum for quinine, for this was the value obtained on both the Aminco-Bowman and the Farrand instruments when these were set at their respective activation maxima, namely, 365 mμ and 350 mμ. Although it would be highly desirable to have the activation and fluorescence maxima of a given compound measure to within 1-mμ precision on instruments of different manufacturers to permit absolute standardization, this is an ideal yet to be activated in the development of spectrophotofluorometry. Many instrumental factors that are known to affect fluorescence (*11*) must be standardized before this can be effected. According to Bowen and Wokes (*11*), the best practical solution to the problem at present is "to use a *figure of merit*, the lowest concentration of suitably selected fluorescent solutions whose fluorescence can be measured with an average error of some agreed amount."

Once the activation and fluorescent maxima had been worked out, the following data were obtained: (i) the widest range of quinine concentrations within which these maxima were constant (this was an essential preliminary to the development of a quinine calibration curve); and (ii) the range of quinine concentrations (within the aforementioned range) that gave a linear response as measured by fluorescence intensity. From these observations, a linear calibration curve for quinine could be plotted. By determining one or two values on the quinine calibration curve from day to day, we could thus rapidly check the instrument for accuracy before proceeding to the assay of other compounds.

The results are set forth in detail in Table 1. For this work, all quinine concentrations were made up in 0.1*N* H_2SO_4. Only maximum activation and fluorescence peaks are listed; activation maxima were corrected by subtracting a factor of 15 mμ for the reasons described. Corresponding activation and fluorescence maxima were constant over a quinine range from 0.005 to 10 μg/ml. A reagent blank consisting of 0.1*N* H_2SO_4 exhibited per se only scatter peaks throughout the range of the wavelength disks. Fluorescence intensity was obtained by multiplying the galvanometer needle deflection (transmission scale) by the meter multiplier readings on the Aminco photomultiplier microphotometer. A plot from data in Table 1 of fluorescence intensity (ordinate) versus quinine concentration (abscissa) measured at activation maximum of 350 mμ (corrected) and fluorescence maximum 450 mμ reveals that the region of linearity in the resulting calibration curve extends from a concentration range of 0.005 to 0.1 μg/ml, approximately. This compares favorably with data obtained by Wokes *et al.* (*12*) on the Spekker fluorimeter.

Table 1. Effect of concentration on the spectral activation and fluorescence maxima of quinine.

Quinine concentration (μg/ml)	Wavelength (mμ)			
	Activation maximum		Fluorescence maximum	Fluorescence intensity
	Observed	Corrected		
100.0	380	365	450	59.5
10.0	365	350	450	20.7
1.0	365	350	450	2.44
0.10	365	350	450	1.87
0.08	365	350	450	1.59
0.05	365	350	450	1.04
0.03	365	350	450	0.65
0.01	365	350	450	0.23
0.008	365	350	450	0.19
0.005	365	350	450	0.12
0.001	365	350	410	0.06
0.0005	365	350	405	0.04
0.0001	375	360	405	0.05

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* Research associate supported by U.S. Public Health Service grant No. M-1015(c). Present address: New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, N.J.

26 October 1956

Minnesota Cretaceous Pine Pollen

Although plant fossils from Cretaceous sediments in Minnesota are generally poorly preserved and fragmentary, there have been occasional noteworthy finds. Chaney (*1*) has described a pine cone (*Pinus clementsii*) from Springfield, Minn., that is morphologically identical to the cones of *P. resinosa* Ait., the red pine, a species still found in the northeastern part of the state. Contemporaneous deposits from New Ulm, 25 miles east of Springfield, have yielded impressions of pine needles also similar to *P. resinosa*.

This report (*2*) is based on a preliminary analysis of sediments that occur in the vicinity of New Ulm. These deposits are assigned to the early Upper Cretaceous Dakota Series [(sensu lat.) (*3*)] and represent sediments deposited on flood plains, in stream and river channels, and in lakes or catchment basins. Extensive exposures occur sporadically along both banks of the Big Cottonwood River between Springfield and New Ulm. Coarse to fine sands, often cross-bedded and occasionally cemented, comprise the main fabric of the formation in the area, but seams of shaly clays ranging in thickness from a few millimeters to several feet are not uncommon. In some of the clay seams, intact leaf cuticles occur; because of their excellent preservation, it was thought that plant microfossils might also be present.

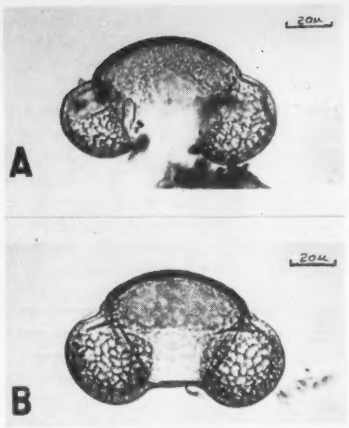

Fig. 1. (*A*) Lateral view of Cretaceous pine pollen. *Pinus resinosipites* sp. nov. (low mid-focus; slide PKP 24L-3; location, 18.9×119.2 (ref. 57.7×127.6). Vesiculated grain; bladders with coarse, internal reticulations, constricted at base (*sylvestris* type); marginal crest poorly developed; exine granular; size across widest part of body exclusive of wings, 58.4 μ; size including wings, 84.5 μ. The holotype is in the paleobotanical collection at the University of Minnesota (*7*). (*B*) Lateral view of red pine pollen.

Past analysis (*4*) of sediments of this age yielded little information, for only spores of undetermined botanical origin were recovered. My samples, when treated by Traverse's methods (*5*), provided moderately abundant spores and pollen the preservation of which is comparable to that of pollen from early postglacial peat deposits. The comparative analysis of these microfossils is still in its initial stages, but sufficient observations have been made to indicate that abietineous pollen is the most abundant (*6*).

In the accompanying figure, one such grain (Fig. 1*A*) is shown above a grain from red pine (Fig. 1*B*); both grains have been acetolyzed. There is no discernible difference between this grain and the pollen of *P. resinosa*; however, this is not unequivocal evidence that the two grains are specifically identical. Interspecific variation in the pollen of the Abietineae is slight. Descriptively, the pollen of *P. strobus, P. echinata, P. sylvestris,* and Wodehouse's pollen species *P. scopulipites* seem quite similar to the pollen of *P. resinosa*. Differences in body size and marginal crest development are not great enough for reliable use in identification of single grains, but Cain's (*8*) size-frequency data do show that this grain's body size corresponds with the average for *P. resinosa*.

With the addition of this information to the fossil record, together with the cone and foliage previously described by Chaney, it appears likely that one of the Cretaceous pines of Minnesota has a counterpart in the living red pine. It would seem unwise to conclude that red pine has existed as a specific entity since the Cretaceous, for its Tertiary record is unknown, but the morphological evidence is temptingly suggestive. If the relationship indicated by the fossil record was accompanied by an ecological similarity, there must have been heights of land sufficiently elevated to cause a vertical floral zonation, for the remainder of the fossil record of this stage indicates warm temperate conditions.

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15 October 1956

Book Reviews

Evolution: the Ages and Tomorrow. G. Murray McKinley. Ronald Press, New York, 1956. 275 pp. $4.

To generalize from one's professional experience holds a fascination for reflective men. In recent years, biologically grounded philosophies or philosophically grounded biologies have been written by many men, including Maritain and Bertalanffy, whose viewpoints are rather orthodox; Simpson and Haldane, whose viewpoints are materialistic; and Sinnott, who has followed a *via media*. G. Murray McKinley has now attempted to explore the philosophical consequences of evolution.

Chapters 1–6 summarize the mechanics of evolution and its historical course; chapters 7–12 are concerned with comparative psychology and sociology; and chapters 13–17 explore specific evolutionary-biological-sociological problems confronting man, and the entire thesis of the book is here summed up.

In brief, McKinley's thesis is "that very definitely there is purpose in the universe . . . there is but one over-all trend and direction to all phenomena—that of the eternal striving of cosmic energy toward greater conscious understanding." However, *purpose*, as here used, is not Divine purpose; it is simply a basic property of "mind-matter-energy." ". . . the carbon atom . . . is capable of forming exceedingly complex substances . . . we are assigning purpose to this atom when we review its behavior. . . ." Perhaps so, but this does so much violence to the usual definition that one wonders whether a construct based upon it can be other than misleading.

Biological data are presented so scantily and inaccurately that they are uninstructive to biologists and uninterpretable to others. The entire phylogenetic record, both plant and animal, is summarized in 12 pages—little wonder that it is superficial. On page 49, we are told that "Man is a worm with accessories," while on page 50 the author concedes that the echinoderm theory of chordate origin is better founded. Population geneticists will be surprised to learn on page 42 that "Very small populations endanger the organism . . . due to the purely random nature of the mutant changes . . . ," while ". . . a group must be large enough to show gene drift by differential reproduction."

Those who are already in agreement with McKinley will find his book an interesting confirmation of their views, although they may be irritated by the numerous errors and logical gaps. Those who disagree with him are unlikely to be convinced.

EDWARD O. DODSON
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Dermatology. Donald M. Pillsbury, Walter B. Shelley, and Albert M. Kligman. Saunders, Philadelphia, 1956. 1331 pp. Illus. $20.

This first edition is a cooperative appraisal of knowledge in the field of cutaneous medicine by members of one of the outstanding university departments of dermatology. Inasmuch as I was an undergraduate medical student in the University of Pennsylvania and later received my graduate training in the specialty at the Graduate School of Medicine of the same university, I am one of many who have been looking forward to this crystallization of the experience of the department of dermatology of that institution.

The first of the five general sections of the book covers fundamental principles in diseases of the skin; it is unusually well done and in itself makes the purchase of the volume a worth-while investment. The section is composed of a series of 13 superbly summarized essays on the basic sciences pertaining to dermatology. Of these, the chapters on keratinization, hair, skin glands, corium and subcutaneous tissue, and the fundamentals of cutaneous mycology and microbiology are outstanding.

The chapter on hereditary skin disorders begins with a useful 13-page outline of the fundamentals of inheritance. Equally worth while is the chapter on psychosomatic skin diseases, or psychocutaneous medicine—an important and difficult portion of the specialty.

The chapter on industrial dermatoses, a field in which I devoted full time to research and investigation before the onset of World War II, is well written. It has been kept within space limitations by restricting it to a discussion of sources and a review of the industries in which occupational skin diseases most often occur.

Throughout the book, the authors have questioned the extent to which many widely held tenets of dermatology are sustained by experimental evidence; they have made a definite effort to weigh and evaluate the accumulated literature and to reach a decision on the validity of the often loosely reasoned acceptance of causal relationships in affairs of the skin.

In view of the meager time allotted to dermatology in the curriculums of most medical schools, Pillsbury, Shelley, and Kligman have wisely devoted more emphasis to their presentation of the basic science aspects of cutaneous medicine, although clinical detail has not been slighted. For this reason, the volume should prove to be especially useful as a textbook in schools where attempts are now being made to add cutaneous physiology and pathology to the subjects taught in the preclinical years.

The authors have maintained a high standard in their selection of illustrations and have drawn mainly on cases handled at the University of Pennsylvania during the last decade. The volume has a sturdy binding—an essential feature in a book that weighs 6½ pounds. The textbook ably fulfills the writers' aim to "keep in mind constantly the viewpoint of students and physicians who have had little or no experience with skin diseases and whose preclinical training has not included any acquaintance with the fundamental aspects of skin physiology."

This book contains 1117 illustrations.

LEON H. WARREN
Parke, Davis & Company

Treatise on Inorganic Chemistry. vol. II, *Sub-Groups of the Periodic Table and General Topics.* H. Remy. Translated by J. S. Anderson. J. Kleinberg, Ed. Elsevier, Amsterdam–Princeton, N.J., 1956. 800 pp. Illus. $17.75.

This textbook, constituting volume II of Remy's *Treatise on Inorganic Chemistry*, is a translation based essentially on the seventh and eighth German editions, with new material added on chemical bonds, radioactivity, nuclear chemistry, and the transuranic elements. The first German edition appeared in 1931.

Volume II contains 19 chapters, an appendix, a name index, and a subject index. It is confined to the subgroups of the Periodic System and to general topics. The chapters are headed as follows: metals and intermetallic phases; third subgroup, scandium, yttrium, lanthanum,

and actinium; fourth subgroup, titanium, zirconium, hafnium, and thorium; fifth subgroup, vanadium, niobium, tantalum, and (protoactinium); sixth subgroup, chromium, molybdenum, tungsten, and uranium; seventh subgroup, manganese, technetium, and rhenium; eighth subgroup, metals of the iron group and the platinum metals; first subgroup, copper, silver, and gold; second subgroup, zinc, cadmium, and mercury; the lanthanide series; radioactivity and isotopy; isotopy of the stable elements; artificial radioactivity and nuclear chemistry; the transuranic elements; distribution of the elements, geochemistry; colloids and surface chemistry; catalysis and reaction kinetics; reactions in nonaqueous solutions; reactions of solid substances.

Volume I (not reviewed here) consists of 18 chapters which cover the remaining chemical elements of the Periodic System as well as such subjects as valence and affinity, crystal structure and x-rays, constitution and properties, coordination theory, alloys, oxidation and reduction, salt formation and neutralization, the hydrogen spectrum, and the Periodic System.

Volume II in its translated form is a welcome addition to the literature in English on inorganic chemistry. The subject matter of the chapters is well chosen and presented. The descriptive sections are enhanced in value through numerous tables and figures. As a college textbook it should appeal to the student. As a ready reference work for the research chemist or engineer, it should serve a useful purpose. The translator has turned the German text into smooth, excellent English.

RALEIGH GILCHRIST
National Bureau of Standards

Exploration for Nuclear Raw Materials. Robert D. Nininger, Ed. Van Nostrand, Princeton, N.J., 1956. 293 pp. Illus. $7.50.

This is one of the Geneva Series on the Peaceful Uses of Atomic Energy under the editorship of James G. Beckerley.

Part I describes the geology of uranium and thorium from genesis to natural occurrence of these two elements, drawing upon five of the 96 papers from 17 countries presented at Geneva in August 1955. The five used are all by American authors with about half of the first part taken from P. F. Kerr's "Natural occurrence of uranium and thorium."

Part II discusses the techniques of prospecting for these two elements and draws on 25 of the 27 Geneva papers in this field presented from nine countries. After the expected techniques are described, botanical and hydrogeochemical prospecting are described. Then comes a discussion of exploratory drilling, finally a chapter on subsurface radiometric technique. The index seems to be complete.

Considering that this book is a composite, edited from 103 papers, one can understand that it is slow reading. Nininger has accomplished a wonderful job in putting it together with coherence and clarity. He has taken the papers, sorted them out into logical order, and made a readable book. It should have a place awaiting it.

E. WILLARD BERRY
Duke University

Travels and Traditions of Waterfowl. H. Albert Hochbaum. University of Minnesota Press, Minneapolis, 1955. xii + 301 pp. Illus. $5.

To a lifelong student of migration, like myself, this latest work from the pen of "Al" Hochbaum can be cited only with acclaim. It is replete with his personal experiences as director for 14 years of the Waterfowl Research Station at Delta, Manitoba. In addition, the author shows an almost voracious appetite for the literature bearing on this fascinating subject. The book is exceptionally well documented with quotations from many experts in the field, all well tied to the author's own observations and experiences. As is indicated by the title, it is heavily slanted toward the movements of waterfowl, although the migratory habits of the song and other nongame species are brought into the picture.

The work is divided into three parts. Part I deals with the "Travels of waterfowl" and, under chapter headings, discusses the patterns of local movement; learned response to the environment; the visual world; the function of memory; the aerial environment; and awareness of time and space. Part II is headed "Migrations of waterfowl" and has chapters on the cycle of migration; flight trails south; homeward migration; the classification of waterfowl travel; the dimensions of travel; the influence of bad weather; overseas migration; and awareness of direction. Part III, "Traditions of waterfowl" has chapters on biological traditions; building new traditions; tradition and racial isolation; and broken traditions. The book concludes with a well-organized bibliography; a short chapter on the nomenclature of birds in which the author presents a list (both vernacular and scientific names) of the birds mentioned in the text, preceded by comments of his own, chiefly on the spelling of certain names; acknowledgments to his many colleagues and collaborators; a list of specialists; and a subject index.

The entire work is in lay language with a delightful blend of the experiences of the naturalist and hunter with those of the scientist. To this end, the serious student of migration, the amateur naturalist, and the sportsman will find in it much food for reflective thought. Not all specialists will agree with some of Hochbaum's conclusions, but all will agree that, almost without exception, he presents lucid discussions of the known facts. To condense into 300 pages of readable prose so much of our present-day knowledge of bird migration is a major accomplishment and marks the *Travels and Traditions of Waterfowl* as a distinctive book.

It would do the author an injustice to refrain from reference to the many excellent illustrations—also from his pen. They show that he is as competent as an artist as he is as a naturalist. It also should be recorded that in October 1945 Hochbaum was awarded the coveted Brewster medal by the American Ornithologists' Union in recognition of the high caliber of his earlier work *The Canvasback on a Prairie Marsh,* which was also based upon his waterfowl studies at the Delta Research Station.

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Electricité. Y. Rocard. Masson, Paris, ed. 2, 1956. 613 pp. Illus. Cloth, F. 3500; paper, F. 3000.

In this work the author attempts to describe all electric and electromagnetic phenomena from those found in a first course in physics to those in a graduate-level course in electricity. On the average, the plane of discussion is near that of an intermediate course in electricity. It is assumed that the reader has some facility in mathematics and thus is familiar with the common vector operations, simple manipulations with complex variables, linear differential equations, and series expansions.

The book is characterized by considerable breadth in the range of topics treated. This range is indicated by a list of the section headings: electrostatics, magnetism, electrokinetics, electrodynamics, alternating currents, propagation of radiation, free electrons (including electron optics, photoelectricity, thermionic emission, and electron tubes), ionic conductors and semiconductors, and units.

A strong point of the work is that the author gives a clear and logical physical description of each phenomenon he introduces and thus keeps in focus the field of electricity as interrelated physical phenomena. The related mathematical treatment is given secondary emphasis. A great many illustrative examples are solved in order to show the applications

of general principles to specific situations. The book is not limited to classical electricity and magnetism but devotes some attention to relatively recent developments, such as semiconductors, wave guides, and transistors.

A serious drawback from the textbook viewpoint is that no problems for student solution are included. The most serious omission of subject matter is that of the thermoelectric phenomena. The reader is left with the impression that the treatment of electricity is broad rather than deep and that, in fact, the discussion of many topics is superficial. This is an expected consequence of the attempt at covering such a wide range of topics.

V. A. JOHNSON

Purdue University

The World of Learning, 1956. Europa Publications, London, ed. 7, 1956. 1064 pp. $18.50.

This widely useful reference volume gives information on educational, technological, and cultural institutions in more than 80 countries. For each country, information is given about learned societies and research institutions (names, addresses, publications, principal officers, number of members, and sometimes names of members); libraries, museums, and art galleries (names, addresses, size and nature of collections, publications, names of officers, and sometimes brief historical descriptions); colleges and universities (names, locations, chief officers, enrollment, and sometimes names of professors.

As is inevitable in a book of such scope and for which the information had to be collected from so many sources, the information varies from entry to entry and is not always complete. The new, seventh, edition is, however, more complete than its predecessors. It also includes an introductory section on international agencies—UNESCO, the International Council of Scientific Unions, and others. The book is an excellent reference source on the world of learning, particularly for countries other than one's own.—D. W.

Rayonnements de Particules Atomiques, Electrons et Photons. Andre Berthelot. Masson, Paris, 1956. 192 pp. Illus. F. 1800, paper.

A book reviewer usually gets some help when he starts to write his review from the author himself. It is customary to start a book with some kind of foreword written by the author himself or, at least, a preface written by somebody else. None of these is given here and, therefore, the reviewer has to start from scratch. However, on opening the volume, the first page indicates that it is obviously a textbook, a textbook designed primarily for a graduate course. Its title covers a rather wide range, and a possible English equivalent could be *Introduction to Scattering Phenomena.* In trying to find some similar book in the American literature, I looked in vain. It would correspond to something like an introduction to atomic collisions, or an introduction to nuclear physics, or a cross between the two.

In 12 compact chapters there is an amazing amount of material, some of it perhaps even too condensed, but nevertheless it offers us a very interesting introduction into the subject. The chapter headings are as follows and in this order: "Review of some generalities"; "Theory of elastic corpuscular collisions"; "Generalities on atoms in movement"; "Variations of the state of charge of light atoms in movement"; "Slowing down of light atomic particles"; "Ionization produced by atomic particles in movement"; "Range of light atomic particles"; "Coulomb interaction of light atomic particles with nuclei"; "Slowing down of fission fragments"; "The electrons: general considerations and theoretical results"; "The electrons: experimental aspects"; "The photons."

The treatment is essentially experimental. There are a certain number of theoretical expressions given but without any derivations. The experimental material is illustrated very amply with many curves and other illustrated material. This illustrated material is more often than not limited to the presentation of the results with relatively little indication about the method used for achieving the results.

More often than not the student who wishes to find out how the results have been achieved will have to find it from the literature which is reasonably well quoted in the references at the end of the chapters. The words "reasonably well" indicate that not all chapters have references; some chapters which are relatively long do not have references at all. The best documented chapters are those on the slowing down of light atomic particles and the two chapters on the electrons. These three chapters take up two-thirds of all the references. Five chapters have distributed among them another third of the references, whereas four chapters do not have any references at all. The choice of the references is somewhat uneven. In areas with which the author is quite familiar, they are quite up to date and well chosen. In other areas with which the author is probably less familiar, they are sometimes surprisingly old references, and no attempt is made to make an up-to-date review.

Nevertheless, the book is a very interesting attempt at an introduction into collision physics, and I am sure it will be useful not only to the French graduate student but also to the American student who is willing to work on his French and get, in spite of the language barrier, a quick introduction into this field. In fact, it may be worth while to recommend this book as a useful source material for qualifying French language examinations for Ph.D. students. The format of the book is excellent; typesetting and the presentation of the figures are very well done.

L. MARTON

National Bureau of Standards

Books Reviewed in The Scientific Monthly, January

The Exploration of Mars, W. Ley and W. von Braun (Viking). Reviewed by T. S. Gardner.

Earth, Sky and Sea, A. Piccard (Oxford Univ. Press). Reviewed by I. E. Wallen.

Diseases of the Endocrine Glands, L. J. Soffer (Lea and Febiger). Reviewed by J. T. Velardo.

Stratigraphical Palaeontology, E. Neaverson (Clarendon Press). Reviewed by E. W. Berry.

The Human Heredity Handbook, A. Scheingeld (Lippincott). Reviewed by H. H. Smith.

Surgical Treatment of Penetrating Wounds of the Heart, Pericardium and Mediastinum, N. I. Grigor'ev (State Publishing House of Medical Literature, Moscow). Reviewed by S. A. Corson.

The Psychology of Occupations, A. Roe (Wiley; Chapman and Hall). Reviewed by L. E. Tyler.

A Scientific Sampler, R. Stevens, H. F. Hamacher, A. A. Smith, Eds. (Van Nostrand).

Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability, vol. V, J. Neyman, Ed. (University of California Press). Reviewed by K. A. Brownlee.

Varieties of Human Value, C. Morris (University of Chicago Press). Reviewed by W. F. Dukes.

How to Make and Use a Telescope, H. P. Wilkins and P. Moore (Norton). Reviewed by F. K. Edmondson.

New Books

Indian Students on an American Campus. Richard D. Lambert and Marvin Bressler. University of Minnesota Press, Minneapolis, 1956. 122 pp. $3.

Beiträge zur Geschichte der Erkenntnis des Erdmagnetismus. Heinz Balmer. Sauerlander, Aarau, Switzerland, 1956. 892 pp. F. 31.10.

Separation and Purification. vol. III, pt. 1 of *Technique of Organic Chemistry.* Arnold Weissberger, Ed. Interscience, New York, ed. 2, 1956. 873 pp. $17.50.

The Land Called Me. An autobiography. E. John Russell. Allen & Unwin, London, 1956. 286 pp. $5.75.

Meetings and Societies

Symposium on X-ray Microscopy

A symposium on x-ray microscopy and microradiography was held in the Cavendish Laboratory, Cambridge, England, during the period 16–21 Aug. It was sponsored by the International Union of Pure and Applied Physics and was financially aided by UNESCO and by British industrial patrons. There is no formal organization of workers in this field, and the successful conduct of the symposium, and indeed its conception, are traceable to the personal efforts of V. E. Cosslett of the Cavendish Laboratory, a leading center of investigation in the field of microscopy with x-rays.

The opportunities of the symposium were open to interested scientists everywhere, and 125 persons, from 12 countries, attended. In the program of 66 papers all of these sources were represented, and contributions to be read in absence were received from two others (Uruguay and the U.S.S.R.). The members of the symposium could be identified as physicists, physical chemists, biologists, medical scientists, metallurgists, electronic theorists, and advanced scientific technicians.

The recent growth of interest in x-ray microscopy has been supported in part by the theoretical possibility of obtaining high resolution with the short x-ray waves, but the actual resolutions claimed thus far have resembled those obtained by optical and ultraviolet methods and promise no competition for the electron microscope in the matter of resolving power, except insofar as x-ray methods may be used in the preparation of specimens for electron microscopy. The specific advantages of x-ray microscopy lie in the wide range of penetrating powers available, its great focal depth, and its promise of microchemical and microphysical analysis through the combination of microscopy with methods of differential absorption, emission, fluorescence, and diffraction. The possibility of moderately high-resolution microscopy without desiccation of the specimen is appealing in some fields.

The Cambridge symposium was opened by N. F. Mott as president of IUPAP and head of the Cavendish Laboratory. A general survey of the field by Cosslett was followed by general accounts of the three methods which have been most intently studied. These presentations were by P. Kirkpatrick (Stanford) on the grazing-incidence reflection method, A. Engström (Stockholm) on the techniques of contact microradiography, and W. C. Nixon (Cambridge) who discussed the shadow projection method employing a micro-focus x-ray source. The problems, accomplishments, and prospects of these three methods were examined in greater detail by the speakers who appeared on succeeding days. Other methods were also examined, and many related theoretical and experimental developments were disclosed and discussed on the floor, to the undoubted benefit of this interdisciplinary scientific area. The formal papers and some of the impromptu discussion are to be made generally available in book form.

To facilitate continued cooperative activity and communication in x-ray microscopy, a small committee was formed and charged with the duties of studying possible forms of organization, taking steps to develop a specialized abstracting service, and planning a second symposium which is now tentatively scheduled for 1959 in Stockholm.

PAUL KIRKPATRICK
Stanford University,
Stanford, California

Conference on Tissue Culture

On 8–12 Oct. 1956 at Woodstock, Vt., 256 scientists from a dozen countries, including England, Wales, France, Belgium, Holland, Switzerland, Germany, Italy, Sweden, Jugoslavia, Brazil, Israel, and India, gathered under the sponsorship of the Tissue Culture Association to review progress in the use of tissue culture during the past 10 years and to plan for the next decade.

Tissue culture is the method by which the tiny cells of which all living creatures—plants, animals, and men—are made up, are taken out of the body, grown under controlled conditions, and studied as living functioning individuals so that we may better understand how they interact in the body to bring about growth and to produce those states which we call "health" or "disease." Best known to the public for its contribution in making possible the production of vaccines—the Salk vaccine is grown in tissue cultures of monkey and human tissues, eliminating the use of living animals—the method is being increasingly used in the study of many medical and biological problems.

The 4-day program was divided into four sessions (nutrition, morphogenesis (the origin of form and function), viruses, and cancer), and each session was in turn divided into four parts (study of plants, of animals, of related collateral fields, and of future trends).

The highlights of the program on the first day were papers on the development of relatively simple defined nutrients in which such cultures can be maintained. Of especial interest in this group were the papers by Waymouth (Bar Harbor, Me.), Evans (National Cancer Institute, Bethesda, Md.), Parker (Toronto, Canada), Morgan (Ottawa, Canada), and Street (Swansea, Wales). Waymouth and Street have, in their work, followed the leadership of White, also of Bar Harbor, who is currently president of the Tissue Culture Association and who organized the conference.

Outstanding on the second day was the fascinating work of Moscona (Israel), Grobstein (U.S.A.), and Wolff (France), in which animal organs such as kidney were broken down into a brew of single cells by partial digestion, stopping short of killing the cells, and then recombined so that, for example, a kidney made up of mixed chicken and mouse cells yet capable of at least partial function was formed. This, together with the work on cultivation of whole organs by Gaillard (Belgium), Fell (England), Martinovitch (Yugoslavia), and others, provides the basis for, we may hope, the ultimate provision of "spare parts" for damaged bodies, a beginning of which was dramatically shown in a movie on the preparation of human skin and bone "banks" and their use, shown by Hyatt (U.S. Naval Research Center, Bethesda, Md.).

The third day was highlighted by descriptions of methods of growing viruses in tissue cultures, by Syverton (Minneapolis), their study and diagnosis by Melnick (Yale University) and others, the ways in which viruses attack cells as seen in the electron microscope by Bang (Johns Hopkins), and the probable future of this approach by John Enders (Childrens Hospital, Boston) who received the Nobel prize last year for his work on viruses in tissue culture.

The last day, devoted to tissue culture in cancer research, was noteworthy for the discussion of studies on cancer in plants by use of tissue-culture methods, presented by Braun (Rockefeller Insti-

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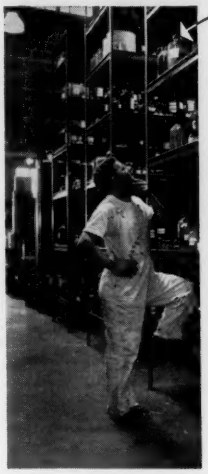

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Both of these compounds work by reducing phosphomolybdic acid to a blue pigment which is reputed to be a mixture of molybdenum oxides. The phosphomolybdic acid is the result of an affinity between molybdate and phosphate ions. This is the basis of the usual method of measuring either total organic phosphorus, phosphate ion itself, or that biological touchstone phosphatase (in terms of the phosphate released under standard conditions from a glycerophosphate substrate).

The trouble with good old ANS is that it gives precious little blue color to measure unless you are working with amounts of phosphorus up in micrograms, and what little color you get is an evanescent thing. Furthermore, we are in a position to reveal that the soul can be tried in the course of purifying 1-amino-2-naphthol-4-sulfonic acid, preventing it from turning a nasty purple with the mere passage of the days, and politely answering irate letters from clinical chemists bothered by strange precipitates.

Now it is written somewhere that both benzidine (H_2N-C$_6$H$_4$-C$_6$H$_4$-NH_2) and diphenyline (C$_6$H$_5$-NH-C$_6$H$_4$-NH_2) can also do the job of reducing phosphomolybdate to those blue oxides. Prof. Robert L. Dryer of the State University of Iowa has been kind enough to inform us that he and his associates looked into this and found neither does it very satisfactorily, except for one sample of diphenyline they tried. When a highly purified diphenyline failed to work as well as that one lucky sample, they laid down their cuvettes and reflected.

The idea that diphenyline is diphenyline is obviously only a convenient idealization. In pitiless chemical reality, you know that when you set out to make diphenyline, you wind up with a little unreacted starting material, a lot of diphenyline, a little benzidine perhaps, a touch of "semidine" (C$_6$H$_5$-NH-C$_6$H$_4$-NH_2). So they bought some Eastman 2043 (in which case "semidine" was what they were paying for), just to see if this could have been what made that one sample of diphenyline work so well. It was. Apparently it not only reduces phosphomolybdate to a nice blue pigment but the oxidized reagent is itself brightly and conveniently blue as well.

We will happily supply an enthusiastic abstract of procedures, also our latest "List No. 40" of some 3500 Eastman Organic Chemicals. Write Distillation Products Industries, *Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).*

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One such, University Microfilms, 313 North First Street, Ann Arbor, Mich., has set itself the task of microfilming a vast number of past and current periodicals from many fields and many nations. They couch their advertising argument in terms of a quadratic equation in t, the time during which a periodical file is stored, and then in 15 pages of close-set type list all the periodicals which they sell in microfilm form. Prices are comparable with the cost of merely binding paper editions. Of the Augean labors in law and librarianship that made the list possible they say little. Perhaps if you write them, they will send you a copy.

Another of our microfilming dealers, Micro Photo Inc., 4614 Prospect Avenue, Cleveland 3, Ohio, strives for eminence in the newspaper division of the microfilm domain. Their catalog, in addition to the New York *Herald Tribune*, the Las Vegas *Optic*, the Waukegan *Little Fort Porcupine* (March 12, 1845 through March 16, 1847), and some 800 other current and defunct titles, offers also the *Official Gazette of the U. S. Patent Office* in microfilm from 1930 to date.

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tute)—another approach pioneered by White—on the use of the semiliquid (ascites) tumors in studies of tumor variation and metabolism, by Klein (Stockholm, Sweden); the use of "windows" attached to the bodies of animals to study the progress of tumors, developed by Algire (National Cancer Institute); and a review of cancer research as it is now being developed in India, by Ranadive (Bombay).

It is certain that this conference will prove as useful in promoting interchange of ideas and stimulating future work as did the much smaller conference in Hershey, Pa., in 1946. The 250 participants in 1956 are a far cry from the 15 tissue culturists present a decade ago.

HASKELL CLEAVES
Jackson Laboratory, Bar Harbor, Maine

Forthcoming Events

January

24–25. Western Spectroscopy Assoc., 4th annual, Los Angeles, Calif. (S. S. Ballard, Scripps Inst. of Oceanography, San Diego 52, Calif.)

25. Bibliographical Soc. of America, New York, N.Y. (H. W. Liebert, Yale Univ. Library, New Haven, Conn.)

25–26. Protein Metabolism, 13th annual conf., New Brunswick, N.J. (W. H. Cole, Rutgers Univ., New Brunswick, N.J.)

28–29. Many Body Problem, symp., Hoboken, N.J. (G. J. Yevick, Dept. of Physics, Stevens Inst. of Technology, Hoboken.)

28–31. American Meteorological Soc., New York, N.Y. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

28–31. Modern Methods of Analytical Chemistry, 10th annual symp., Baton Rouge, La. (P. W. West, Louisiana State University, Baton Rouge.)

30–1. American Assoc. of Physics Teachers, New York, N.Y. (F. Verbrugge, Carleton College, Northfield, Minn.)

30–2. American Physical Soc., annual, New York, N.Y. (K. K. Darrow, APS, Columbia Univ., New York 27.)

30–31. College-Industry Conf., 9th annual, American Soc. for Engineering Education, Los Angeles, Calif. (Univ. of California Extension, Engineering, Los Angeles 24.)

31–1. Digital Computing in the Aircraft Industry, NYU–IBM symposium, New York, N.Y. (M. Woodbury, New York Univ., Research Div., 401 W. 205 St., New York, N.Y.)

31–2. Western Soc. for Clinical Research, 10th annual, Carmel-by-the-Sea, Calif. (A. J. Seaman, WSCR, Univ. of Oregon Medical School, Portland 1.)

February

3. American Assoc. of Bioanalysts, 3rd annual Margaret Beattie Lecture, San Francisco, Calif. (W. N. Reich, Walnut Creek-Lafayette, Laboratories, 1625 Locust St., Walnut Creek, Calif.)

4–8. American Soc. for Testing Materials, Philadelphia, Pa. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3.)

10–12. Canadian Ceramic Soc., 55th annual, Niagara Falls, Ont., Canada. (L. C. Keith, 49 Turner Road, Toronto, Ont.)

14. Present Status of Heart Sound Production and Recording, symp., Buffalo, N.Y. (R. M. Kohn, Univ. of Buffalo, 2183 Main Street, Buffalo 14, N.Y.)

14. Significance of Nucleic Acid Derivatives in Nutrition, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

14–15. Transistor Circuits, conf., Philadelphia, Pa. (G. H. Royer, Westinghouse Electric Corp., 356 Collins Ave., Pittsburgh 6, Pa.)

15–16. National Soc. of Professional Engineers, Charleston, S.C. (P. H. Robbins, 2029 K St., NW, Washington 6.)

15–17. National Assoc. for Research in Science Teaching, annual, Atlantic City, N.J. (C. M. Pruitt, Univ. of Tampa, Tampa, Fla.)

18–20. American Educational Research Assoc., annual, Atlantic City, N. J. (F. W. Hubbard, AERA, 1201 16 St., NW, Washington 6.)

18–22. American Soc. of Civil Engineers, Jackson, Miss. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

18–22. Endocrinology: Hormones in Blood, Ciba Found. Colloq. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Place, London.)

21–23. National Soc. of College Teachers of Education, annual, Chicago, Ill. (C. A. Eggertsen, School of Education, Univ. of Michigan, Ann Arbor.)

23. American Mathematical Soc., New Haven, Conn. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

23. Oregon Acad. of Science, annual, Monmouth, (F. A. Gilfillan, Oregon State College, Corvallis.)

24–28. American Inst. of Mining, Metallurgical and Petroleum Engineers, annual, New Orleans, La. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

24–28. International College of Surgeons, 10th biennial cong., Mexico, D.F., Mexico. (M. Thorek, ICS, 850 W. Irving Park Rd., Chicago 13, Ill.)

25–28. American Soc. of Heating and Air-Conditioning Engineers, Chicago, Ill. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

26–28. Western Joint Computer Conf., Los Angeles, Calif. (M. J. Mendelson, Norden-Ketay Corp., 13210 Crenshaw Blvd., Gardena, Calif.)

March

1–2. American Physical Soc., Norman, Okla. (K. K. Darrow, Columbia Univ., New York 27.)

1–3. National Wildlife Federation, annual, Washington, D.C. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

3–6. American Inst. of Chemical Engineers, White Sulphur Springs, W.Va. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

(See issue of 21 December for comprehensive list)

EQUIPMENT NEWS

All inquiries concerning items listed here should be addressed to Science, ***Room 604, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).***

■ BROMINE CONTAINER is an amber glass reagent bottle with a reusable screw cap. The cap is lined with asbestos, lead, and Teflon. (Mallinckrodt Chemical Works, Dept. S112)

■ ELECTRONIC TACHOMETER model ETC is designed to measure any rates or frequencies that can be presented as electric signals. The instrument counts discrete pulses for a timed interval of 1 sec. The interval is derived from a temperature-controlled crystal that is accurate to 1 part in 10^6. The accuracy of the count is ± 1 pulse. The instrument can be operated from any photoelectric, magnetic, electric, or electromechanical input that produces peaks of from 0.2 to 115 v without marked multiple peaks. (Standard Electric Time Co., Dept. S113)

■ RADIATION-SHIELDING WINDOWS, an information bulletin, presents charts, graphs, and sketches to explain the shielding, transmittance, and radiation-darkening characteristics of Corning's three types of shielding glass. Three pages are devoted to window design. (Corning Glass Works, Dept. S115)

■ CLINICAL CHEMISTRY CONTROL SERUM for use in blood-chemistry analyses has been packaged for laboratory use. The standards are prepared from fresh human blood and dried rapidly at low temperature. All standards are analyzed by three different participating laboratories to assure accuracy. Addition of 5 ml of distilled water to the standard reconstitutes the serum, which remains stable for 5 days if it is stored at 2° to 5°C. (Hyland Laboratories, Dept. S116)

■ ENVIRONMENTAL TEST EQUIPMENT, as well as its applications in biological and industrial testing, is described in a new Tenney brochure. Chambers to simulate the following conditions are covered: cold, heat, humidity, altitude, sunshine, rain, sand and dust, explosive atmosphere, salt fog, and fungus. (Tenney Engineering, Inc., Dept. S117)

■ STANDARDIZED FRACTIONATING COLUMNS for chromatographic analysis are available in either glass or metal. Both types are equipped with make-and-break connectors. Heating coils and thermocouples are optional, and the units are available with or without adsorbents. (Burrell Corp., Dept. S119)

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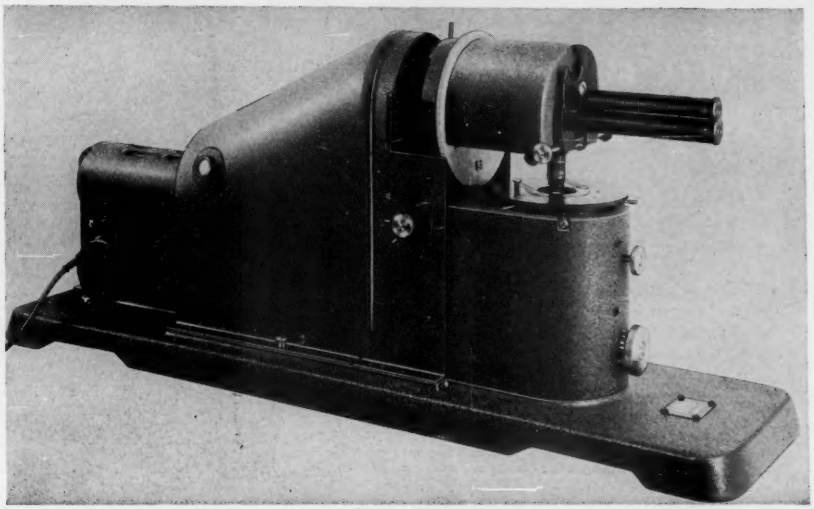

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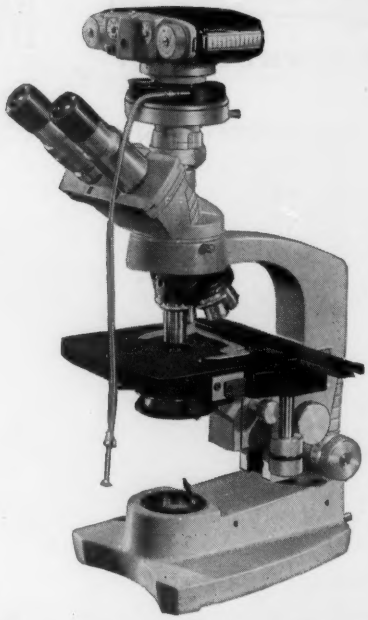

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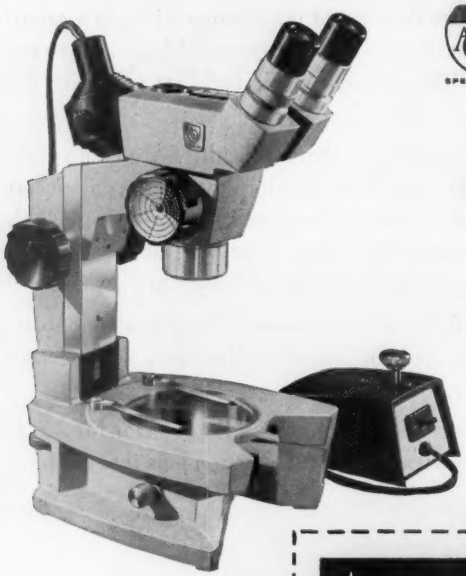

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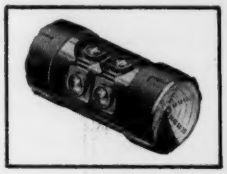

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